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# RESEARCH FOR MARYLAND AGRICULTURE

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SEVENTY-FOURTH ANNUAL REPORT

BULLETIN A-127

JUNE 1962



*Maryland Agricultural Experiment Station*

# RESEARCH FOR MARYLAND AGRICULTURE

SEVENTY-FOURTH ANNUAL REPORT

1960-1961

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VERSITY OF MARYLAND  
CULTURAL EXPERIMENT STATION

BULLETIN A-127  
COLLEGE PARK  
MARYLAND  
JUNE 1962

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1960-1961

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*To The Governor of Maryland,  
the Board of Regents,  
and the President of the University of Maryland*

I transmit herewith the Seventy-Fourth Annual Report of the University of Maryland Agricultural Experiment Station, as established by Act of Congress, March 2, 1887, containing an account of research and experiments conducted during the fiscal year ending June 30, 1961, and a statement of the receipts and disbursements for the same period.



I. C. Haut  
*Director*

## **PREFACE**

Man through the ages has sought out and discovered superior plants and breeds of livestock and has adapted them to his use.

Starting from simple primitive processes of trial and error, agricultural study has gradually developed into one of the elaborate and beneficial sciences of our time. Research is basic to the maintenance of agriculture and to the advance of our civilization.

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Sod-seeded cereal rye in Midland Bermudagrass makes good spring pasture.

## AGRICULTURAL ECONOMICS

Research in the Department of Agricultural Economics is devoted to the application of economic principles to agriculture. This involves establishment of criteria essential to planning for economical utilization of resources, efficient marketing of agricultural products, and the integration of business and industry related to agriculture so as to contribute significantly to economic development.

### Alternative Adjustments in Farm Organization

Patterns of production, distribution and consumption of agricultural products have undergone widespread changes during the last two decades. These changes and adjustments among regions of the country and among individual producing units probably will continue. In most areas, farms have become fewer and larger. Capital requirements for equal levels of income in 1960 were considerably higher than those of 1940. Likewise, the degree of specialization in products, as well as in functions, by individual firms is widely different today from what it was in 1940.

The average annual change in the output of certain vegetable crops in Maryland over the last 20 years was almost opposite of that in the United States as a whole. For example, in the United States the average annual percentage increase in output was 6.0 for tomatoes, 3.8 for snap beans, 2.2 for sweet corn, 2.2 for lima beans, and 1.6 for peas. On the other hand, annual output of sweet corn in Maryland increased at the rate of 5 percent, while that of tomatoes, snap beans, peas and lima beans declined 7.1, 0.34, 0.24 and 0.17 percent, respectively.

Aggregative changes of the kind described above result from decisions and actions of a large number of individuals. In order to find out the influence of

these adjustments on individual farms, adjustment problems faced by individual farms were studied. These analyses indicated that all farmers, even in a relatively small area, face different types of adjustment problems. One of the most distinguishing characteristics observed in a sample of 94 farms on the Eastern Shore of Maryland was the wide variation in quantity and quality of resources used in farming. About one-fifth of farms had an average of 36 acres in cropland (including open pasture), slightly more than two-fifths averaged 160 acres of cropland, and the remainder, or about one-third, averaged 520 acres. Generally, quantities of resources other than land increased as acreage increased.

The adjustment problem faced on these three groups of farms varies rather widely. Present incomes from farming on the small farms was far below that generally assumed to be satisfactory. Furthermore, it is unlikely that family incomes on these farms can be raised to a satisfactory level by increasing output per unit of inputs or by obtaining higher prices. The primary adjustment problem faced by these farmers is to obtain additional farm resources or find off-farm employment.

The second group of farms consists of those which were operated largely

by the farm family with small amounts of hired labor. Except for those on the lower end of the size scale, present inefficiencies likely could be removed by selection of enterprises to permit more intensive utilization of resources and application of "better" farm practices. Individual farms in the third

group varied rather widely. Their common characteristic was the presence of adequate resources for the foundation of efficient production. In some cases incomes probably could be increased by replacing extensive enterprises with more intensive enterprises.

(Project A-18-am)

### **Economic Effects of Vertical Integration**

Increased commercialization of agriculture in the last two or three decades intensified the necessity of linking together the operations of farms with non-farm firms. An increasing proportion of total resources used on many types of farms is obtained from nonfarm firms. Also, most farm products are processed and handled by nonfarm firms between the farm and the consumer. The linking together of these functions through means other than price is called vertical integration or contract farming. Thus far, vertical integration in agriculture has been most prevalent in the production of broilers, hatching eggs and vegetable crops. However, it has been extended to egg production and other livestock enterprises in some areas. Most contracts or agreements contain a promise of the nonfarm firm to furnish certain physical resources as well as certain managerial services. Receipts from the sale of the product are shared by the farm firm and the nonfarm firm.

Among other advantages to farmers such as a source of financing, vertical integration is supposed to shift some of the risk in farm income from the farmer-grower to another party. The major purpose of this project was to obtain some measurement of the degree to which income risk of broiler growers is shifted to nonfarm firms by vertical integration arrangements. Incomes of broiler producers under assumed conditions were estimated for 10 financing plans over the last 13-year period. Aver-

age net income per 1,000 broilers produced was greater for the independent producer than for any of the contract plans. However, the variability in income generally was greater for the so-called independent producer. Therefore, contracts or vertical integration agreements would have permitted growers with insufficient reserves (including conventional credit) to remain in production through severe low-income periods.

In practice, considerable changes occurred in the details as to agreements of resource-and-income-sharing by the respective contracting parties. One of the most important changes in contracts during the last decade in broiler contracts was the inclusion of grower production-efficiency incentives. However, many of the contracts which were included in this study fell short of providing adequate production-efficiency incentives. When it was assumed that feed conversion was 2.5 (2.5 pounds of feed required per pound of broiler meat sold) the results were inconclusive as to the desirability of self-financing plans, as compared with other financing plans. Average level of income was greater in this case for the self-financed grower, but the variability also was greater. However, when feed efficiency was 3.5, several vertically integrated plans ranked higher than the self-financing plan in achieving the dual objective of maximum average income and minimum variability of income.

(Project A-18-aq)

## Economies of Large-Scale Dairy Farming

Modern dairymen operate businesses with more and better cows than a decade or so ago. Perennial questions for managers of dairy farms are: How big should I become? How is my production efficiency likely to increase with expansion in cow numbers? Will the net effect of economies and diseconomies of large size increase my net farm income?

Forty farm organization and operation records for the 1959-60 year have been obtained from Maryland dairy farms ranging in size from 43 to 225 cows with an average of 78 cows and 44 heifers of all ages per farm. These farms had an average labor force of 3.3 man equivalent per farm. The average total size of farm was 364 acres, with 48 percent of this total in cropland. These farms had 175 acres of crops per farm. Only 2.3 acres of cropland was available per cow and replacement. The average labor intensity on these farms was 55 crop acres per worker and 25 cows per worker.

When selected farm business factors were related to farm size, as measured by number of cows, labor intensity with cropland and cows showed some tend-

ency to increase up to the 70-79-cow grouping. The 7 farms in this group had a 2.3 man equivalent average labor force which took care of 75 cows and 51 heifers of all ages. These farms have an average of 33 cows per man and 71 acres of cropland per man, with 22 heifers per man in addition. These farms had an average of 316 total acres, with 164 acres in crops. One cow and replacement stock was carried on each 2.2 acres of cropland.

A similar grouping of Maryland dairy farm survey data for 1956 also showed that labor intensity with cows and crop acres showed no tendency to increase beyond the levels reached in the 70-79-cow farms.

On the basis of these data and other observations, there would seem to be few operating efficiencies available to most dairymen after about 80 cows per herd is attained. However, in most cases, the net farm income to the operator will continue to increase with increased size of herd and volume of milk sales if labor, capital, land and managerial ability are available.

*(Project A-18-ar)*

## Artificial Hay Drying Versus Field Curing

In recent years, there has been much talk and discussion about methods of curing hay artificially. Farmers' experiences and controlled experiments have indicated that artificial drying, as compared with field-curing, results in a larger quantity of a higher quality hay. The major question is "Will the increased returns more than offset the increased drying cost?"

When only small quantities of hay are dried, the costs of drying, in general, will be higher than the returns. When large tonnages of hay are dried the

fixed costs are distributed over more tons of hay, which results in lower costs per ton. This means that artificial hay drying is most likely to be adopted on the dairy farms with large numbers of cattle and large amounts of hay produced.

Farmers with fewer than 30 cows should figure all costs very closely before investing in a home-built mow drier with heat which is likely to be underutilized and uneconomical if fewer than 90 tons of hay are dried annually. Dairymen should compare probable net re-



Management workshop of Fannin Farmer Cooperative, Easton, Maryland.

Inspecting hay-dryer installation.



turns from capital invested in hay driers with probable net returns from other uses of capital.

The mow driers without heat did not increase returns enough to pay variable costs. Likewise, the wagon and platform systems which dried hay from 45 down to 15 percent moisture did not have sufficient returns to cover variable costs. This means that dairymen should rely on natural drying until hay approaches the 30-percent moisture level. In some cases, rain damage will be incurred unless the drying operation is started at high moisture levels. This type of expensive drying may be unavoidable occasionally.

The system of hay drying with the

highest average cost of initial investment is the "purchased" wagon drier system with shed. A saving in cash outlay is possible if the farmer can build the wagons and shed. The initial investment will be considerably lower if a tarpaulin is used instead of a shed. About 175 tons of hay dried, or feed for a 60-cow herd, is necessary to reach the break-even point with a home-built four-wagon drier with tarpaulin. Because of the relatively high costs involved, increased net returns from artificial hay drying are likely only under conditions of low initial investment and relatively large tonnages of hay dried.

*(Project A-18-ao)*

## **Quality Goals and Practices of Canners Are Studied**

Vegetable processors differ in practices employed and techniques and facilities used in grading raw products and in controlling and testing the quality of the finished product. These procedures were the subject of a research project which also included a study of processors' quality goals as related to the quality expectations of buyers. In view of the interest in selling the products of member processors through a joint sales organization, as expressed by some sectors of the industry, findings of this study would assist in developing plans for coordinating quality control and grading practices in order to attain uniformity of quality.

According to initial tabulation of data obtained in a survey of 50 vegetable canners, 65 percent used some method of grading as a basis for paying growers or processing vegetables. Lima beans and tomatoes were the principal commodities for which grading served as the basis for quality-price differentials.

Processors who grow some or all of their raw product have direct control

over cultural and harvesting practices affecting quality. Processors with annual volumes under 150,000 cases grew an average of 26 percent of their raw product, as compared with 15 percent for the larger processors with annual volumes over 500,000 cases.

For vegetables grown under contract, processors had some control over quality of raw product through contract provisions concerning varieties, fertilization, spraying and harvesting methods. In this study, all processors of corn, peas and lima beans procured raw product exclusively by contract. About 28 percent of the snap bean processors and 33 percent of the tomato processors purchased these commodities exclusively on the open market. Only 28 percent of the processors stated that they plan to improve the quality level of their processed products. Reasons given for not planning to change were, in order: (1) Present quality level is satisfactory to the trade; (2) it would not be considered profitable to pack a higher grade; and (3) weather con-

ditions are too variable to warrant more stringent quality control.

Another phase of the study will compare processors and buyers with reference to: (1) Their evaluation of the

quality of two selected, unidentified samples of canned tomatoes, green beans and sweet corn; and (2) their criteria for evaluating quality.

(Project A-26-ba)

## **Survey of Baltimore-Washington Areas Contained Eye-Opening Facts for the Broiler Industry**

A survey was made with 69 wholesale-distributors, 1,060 retail stores or their representatives, and 2,004 consumers in the two-city area. All contacts were made by personal interview with the exception of the consumer surveys which was conducted by telephone interview.

At the wholesale-distributor level, the City of Baltimore obtained 49 percent and Washington 56 percent of total broiler needs from North Carolina. The Delmarva area, including the Eastern Shore of Maryland, Delaware and Virginia, supplied 28 percent in Baltimore and 13 percent of total needs in Washington. Traffic congestion in the wholesale markets, lack of storage facilities, and crowded conditions were a few of the problems distributors faced.

Approximately 2,000 retail stores in the two cities dispersed 1,600,000 pounds of poultry per week. An estimated 87 percent of this volume was handled by chain stores and 13 percent by independents and corner groceries. In Baltimore, chain stores averaged about 2,000 pounds per store each week, as compared with 154 pounds of chicken sold by independents. Retailers generally preferred to carry their own store identification on poultry meat rather than the producer brand designation.

Most consumers felt that a 29- to 34-cent-a-pound range was "reasonable"; less than 5 percent bought chicken only when advertised as a

weekend special; two-thirds purchased no more chicken when featured as a sale than they normally did; about 60 percent put their chicken in the freezer compartment of the refrigerator.

It was generally concluded that improvements could be made in the quality of poultry sold in the Baltimore and Washington area. Such improvements could be made through State or city legislation, through educational efforts in the area, and/or through better public relations between supply areas and centers of distribution. There was evidence that the market will move in the direction of handling more of the frozen products.

One possibility would be to display chicken in a three-compartment display case where the housewife could buy either hard frozen, partially frozen, or freshly thawed, depending on when she planned to use it. Along with this three-compartment display, there could be made available promotional materials and recipes which would improve consumer acceptance. Also, there was some interest in sales contracts for delivery of the product at specific locations on a regular basis. Production areas may be able to improve sales by gearing more of their sales and promotional programs to chain stores and feeding establishments in view of the fact that the number of retail stores and wholesale-distributors in the two city area is declining.

(Project A-26-be)



Typical display of fresh fryers in retail stores of the Baltimore-Washington market area.

### Status of Membership Relations for Maryland Farmer Cooperatives

It is essential for a modern farmer cooperative association to have a well-informed membership, and for the cooperative officials to be aware of the needs and desires of all members. The membership relations and educational programs of 12 local cooperatives were analyzed for their effectiveness.

Cooperative education work with farm youth was found to be practically non-existent on a local level. Slightly over half the associations reported making financial contributions to local farm youth activities.

With the exception of personal contacts by store managers, warehouse or delivery personnel, the annual meetings were the primary means of contacting the membership. The average attendance at annual meetings was approximately 21 percent of the voting members. Voting members made up only 41 percent of the total persons attending the annual meetings. The cost of the annual meeting per person was 87 cents, while the cost per voting member present was \$1.26.

Ten of the 12 cooperatives reported having regularly distributed house organs. Seven distributed the official monthly publication of the regional cooperative with which they were affiliated. Two independent locals published their own monthly, and one distributed a bi-weekly publication of one of their suppliers. Only four cooperatives had 100 percent of their members on their mailing lists.

Seven of the local cooperatives reported having related women's organizations, but none of the cooperatives had women's programs which were an integral part of the membership relations program. It appears that, although Maryland cooperatives do maintain good membership relations, in all cases the manager, the warehouseman and the truckdriver still bear particular obligation to help maintain the best of membership relations for farmer cooperatives in Maryland.

Membership education through the employees who actually meet the member patrons from day to day should be stressed.

*(Project A-26-b)*

## AGRICULTURAL EDUCATION

Research in agricultural education is concerned primarily with helping rural leaders in agriculture work more effectively in raising the educational level of rural youth and adults. As research in technology reveals more and more new information, better methods of disseminating that information must be found. The rapidly changing patterns of human behavior should be based upon the latest and most accurate information available. Research in agricultural education aims to accelerate this process.

### Factors Affecting Academic Success in College

The need for College of Agriculture graduates has been established and is generally recognized. Identification and analysis of educational experiences contributing to successful academic performance in college should be helpful to administrators responsible for educational programs at the college level. A knowledge of the preparation desirable for study in the College of Agriculture should prove valuable.

Literature on the problem was reviewed, and a summary was prepared and distributed to administrators in land-grant colleges and interested researchers. The literature cited indicated successful academic achievement in the College of Agriculture did not depend on the study of specific subject matter in high school. However, there was evidence presented which supported the

concept that previous success as indicated by high school rank was a valid criterion for predicting success in college.

The review of literature revealed that for each student in publicly-supported institutions who failed to maintain college academic standards, his counterpart not in academic difficulty withdrew for other reasons. This study was undertaken to determine why academically able students discontinued their pursuit of a college education in agriculture. Data are currently being collected on students who were not in academic difficulty but terminated their studies prior to graduation. Reasons given by students for discontinuing their education will be analyzed and their plans for continuing will be determined. *(Project T-6 1960-61)*

## AGRICULTURAL ENGINEERING

Agricultural engineering research objectives are to devise or improve equipment and facilities for the production, processing, storage, and utilization or marketing of agricultural products. Research studies are conducted in cooperation with other departments, with the Agricultural Engineering Department providing the engineering knowledge, equipment and skills.

In a report of this type, resumés of only the most important activities can be given. Details are given in technical papers and bulletins and at field days. The department staff devotes considerable time to consultation with other departments on equipment, controls and instrumentation essential to conduct of their research.

### Production, Harvesting and Curing of Maryland Tobacco

Housing investigations were continued on comparison of natural curing with controlled curing in standard-size barns. The controlled curing was conducted in a cinder-block barn. To modify the curing conditions, facilities were provided to automatically humidify, heat or dry the air. The air could be

re-circulated or outside air taken in. The results were very favorable, the quality about the same for each method. The natural curing conditions were very favorable during this curing period. The same amount, approximately 1 acre of crop was cured in each barn. For the 1959 season, the tobacco



Apparatus for tobacco drying tests by controlled airflow.

finished under the modified curing conditions sold for \$642.12 for an average price of \$67.73 per 100 pounds, while the natural cure sold for \$639.76 for an average of \$68.35 per 100 pounds. Preliminary evaluation of the results for the 1960 crop indicated both lots to be of very good quality.

Loss-of-weight studies showed that during field wilting the tobacco lost 16.6 percent of its initial green weight. This amount to 1.5 to 2 tons of water loss in the field. A comparison of wilted and non-wilted is shown figure on page 9.

Compact curing of Maryland tobacco

follows an entirely new principle. This method consists of packing the tobacco in boxes and forcing air through the boxes to cure the tobacco. In this experiment the tobacco was cut and field wilted. The plants were then packed in a box 2 feet square and 5 feet high. As many plants as possible were placed in the box. The rate of air passing through the boxes was controlled. The tobacco cured by this method was of satisfactory quality with a rate of from 5 to 8 c.f.m. per plant being more desirable.

(Project RB-11-G)

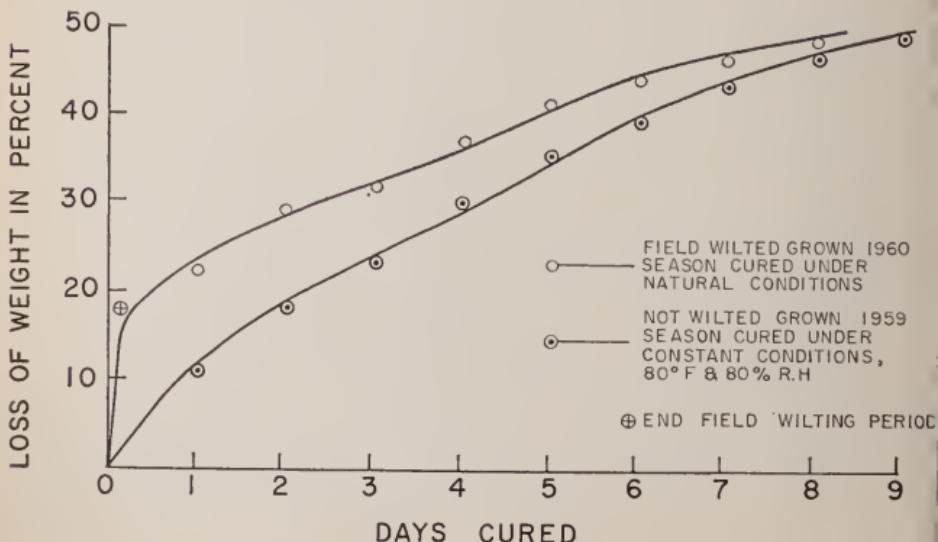
### Mechanization of the Harvest

A tobacco harvester was constructed utilizing principles developed in the tobacco spearing machine. Limited testing was conducted with some difficulty

being encountered. Further modification is planned before more field testing is conducted.

(Project R-11)

### WEIGHT LOSSES OF WILTED AND NOT WILTED MARYLAND TOBACCO



## Pneumatic Handling of Chopped Forage

The objective of this experiment is to determine the design criteria for a pneumatic system for placing wilted chopped hay in a drying chamber. If proved economically feasible, such a system would enable the drying of hay under more favorable conditions than is possible with baled hay.

The system consists of feeding equipment designed to introduce hay into an air stream, fans and 100+ feet of horizontal pipe 14 inches in diameter, and an air-tight receiving chamber. The horizontal pipe and receiving chamber represent a delivery system and hay mow. Air pressures in the pipe and receiving chamber are measured, permitting calculation of airflow and velocities. The pressures, together with fan speeds, permit computation of power requirements.

Data were obtained by locating instruments on a panel to permit instantaneous recording of all readings by use

of a semi-automatic camera during trials. A uniform feeding of hay was accomplished by use of a conveyor 3 feet wide and 84 feet long which was loaded uniformly prior to each test and run at a uniform speed during each test.

A section of plexi-glass tubing was placed in the 14-inch pipe to permit slow-motion photographic study of the flow characteristics of the chopped hay in the pipe. Observations show that the particles of hay do not float as had been expected, but move along more or less by bouncing like particles of sand in a small streambed.

Two fans were used in series to provide a velocity of 5,000 feet per minute with no hay load. A total of 150 tests of 1 minute duration were run with rates of 5.0, 7.5, 10.0, 12.5, 15 and 20 tons per hour with four moisture ranges of 30-35 percent, 35-40 percent, 40-45 percent and 45-50 percent.

(Project R-16)

## Development of Improved Methods and Equipment for Harvesting Sweet Potatoes

The machine constructed for research in separating the crop from the soil in root crop harvesting was modified for use in this project. Several varieties of sweet potatoes were harvested. No problems were encountered in separating the soil from the crop even in heavy soil except when this soil was saturated. Flat-growing varieties, such as Nema-gold, could be readily separated from

the vines. The more upright-growing varieties, such as Gold Rush, provided some troubles in the separating mechanism. The more tough-skinned varieties, such as Gold Rush, could be harvested without serious damage. Nema-gold, due to its tender skin, was seriously damaged, apparently by the sliding action on the grizzly bars.

(Project R-18)

## Principles of Separating Crop From Soil of Harvesting Root Crops

The objective of this project was to determine the interrelated effects of frequency, amplitude, direction, and shape of the time-displacement curve of a vibratory motion on the separation

of the crop from the soil, and to observe effects on the crop.

A machine was designed as a research vehicle, rather than a field implement, and constructed for work on

this project. It provides for a wide range of adjustment of speeds, frequencies, and amplitudes of vibratory motion and it permits readily the exchange of complete separating systems. After its operations were tested in late 1960 some changes were effected to make the machine a better research tool.

This one-row machine is a trailing type, mounted on four wheels, with castored front wheels to permit turning. The frame is 22 feet long and is attached to the tractor by a 3½-foot hitch. The hitch is adjustable laterally to permit adaption to various row widths.

Power take-off drive is provided to permit operation of such parts as elevator chains at speeds relative to the forward speed of the machine. Sprockets permit operation in several tractor gears to provide a reasonable ground speed range.

An auxiliary engine provides power for more convenient control of the speed or frequency of shaker beds and auxiliary equipment.

Two 18-inch rolling coulters eliminate trash interference. To permit digging sweet potatoes without first removing the vines, these coulters have independent hydraulic control for lowering the coulters before lowering the digger shovel.

The shovel is the conventional pointed one used on the 26-inch John Deere digger. Change to other shovel shapes can be made readily.

The elevator is of conventional 26-inch digger chain with alternate links bent up and down. To avoid loss of soil, a sheet steel bottom was provided. This arrangement tended to pack soil under the chain when operating in wet, heavy soil.

The elevator operates at an angle of 26 to 31 degrees when on level soil, de-

pending on depth of digging. The entire frame can be raised or lowered on the wheels to change the angle for different depths.

The elevator discharges the soil with the crop onto the test section for actual separation of crop from soil. Two units have been built for comparative study. One is, in effect, a vibratory conveyor using "grizzly" bars to accomplish the separation while moving the entire material toward the rear. The bars are 56 inches long and are spaced 2 inches center to center. Each bar is topped with a ½-inch O.D. tube covered by ⅛-inch-thick rubber, made from ½-inch x ⅛-inch black laboratory tubing. This provides a free space of 1⅓ inches between bars. Amplitude and frequency of this unit are adjustable over a fairly wide range. The angle of the support arms can also be changed. This controls the relation of the vertical to the horizontal components of the motion. With this unit, every third bar is extended, and with an overhead rake acts as vine-removal equipment. A belt under the vine-removal equipment collects the crop.

The second unit is a conveyor of rubber-covered digger chain of 2-inch pitch, giving a free opening equal to that of the vibratory conveyor unit. The conveyor chain is driven from the elevator chain drive so that its speed can be related directly to ground speed. The carrier frame is mounted on springs and vibration is provided by four cams. Frequency and amplitude are both adjustable.

Determination of minimum forces required to separate Irish or sweet potatoes from the vines and from the soil and the maximum forces which can be used without damaging the crop should lead to designing of improved harvester.

(Project R-20)

## AGRONOMY

Research in agronomy is designed to add to the store of knowledge relating both to soils and to field crops including corn, small grains, forages, soybeans, and tobacco. This effort results in better crop and soil management practices, as well as in good seed of improved varieties.

Research projects are initiated with regard to the need for specific information in the solution of problems, either current or anticipated.

The following brief statements indicate the work now in progress.

### **Random Sampling Applied to Soil Classification**

An old technique, but new in its application to soil classification problems, is being used on soils of the present Manor series to see if they should be classified into two series. In the past the soils of the Manor series (which occupy half of the Piedmont Province) have been separated into two populations at the soil-type level of generalization. The distinction has been made on the basis of coarse-fragment (Channer) content and depth to bedrock. Closer field examination gave indications that there may be differences between these groups that reflect differences in degree of profile development significant enough to warrant distinction at the soil series level.

A study involving random samplings as designed to measure the differences between the groups and also to measure the variation within each group. Chemical and physical determinations are being made on soil samples from 20 profiles which will be used with the morphological data to decide upon the classification problem, as well as for making predictions about the behavior

and capabilities of these soils. The results of this study will also lend evidence to the unsolved basic question of whether taxonomic soil units are "natural" units or "arbitrary" units. Preliminary results indicate that these two groups do differ enough in soil color, sand content, and accumulation of clay in the B horizon to warrant classification in separate soil series.

The end-product of the cooperative soil survey program, which includes the results of such studies as the "Manor" study, is the soil survey report. The soil survey report of Montgomery County was recently issued. In addition to the conventional information about use of the soils for agriculture and engineering it contains special sections about use of the soils for community planning and sewage-disposal systems. Maryland is making special efforts to classify, map, and interpret the soils of built-up areas in accordance with the growing demand for soils information in these areas. The Washington County report was scheduled for issue in 1962.

*(Project O-48)*

### **Clay Mineralogy Studies Help Evaluate Maryland Soils**

Knowing the kinds of clay minerals and their relative distributions through-

out the soil profile aids in explaining the origin of the soil, its proper classi-

fication, and nutrient supplying and holding capacities.

Recent clay mineralogical determinations of some soils from the Appalachian Region indicate that the dominant kinds of clay are inherited from the underlying sandstone and shale. There is some evidence that the low-nutrient holding kaolinite is dominant in soils from sandstone and that the medium-nutrient holding illite is dominant in soils from shale. All of these soils were found to have small amounts

of vermiculite in the surface horizon that is apparently of pedogenetic origin.

Soils in the Middletown Valley were found to have equal amounts of kaolinite and vermiculite in all parts of the profile including the parent material. These soils are known to be capable of "fixing" large amounts of potassium and ammonium fertilizers in a form not readily available to plants. Vermiculite is one of the clay minerals having this "fixing" ability.

(Project O-54)

### **Heavily Fertilized Continuous Corn with Winter Cover Crop Does not Yield as Well as Corn in a Rotation**

Corn in a rotation of corn, wheat, alfalfa, yielded 120 bushels while continuous corn produced 90 bushels in 1960. This is the first year that a large difference has occurred since the experiment was started in 1952, but it is noteworthy because of the large amount of fertilizer used in this experiment. Each plot has received the equivalent of 1,000 pounds per acre of 10-12-12

fertilizer each year since 1952. A rye-vetch cover crop has been seeded in the continuous corn each year. The soil structure in the continuous corn plots has gradually declined during this period; it has increased in the rotation plots. It would appear that large amounts of fertilizer will not produce maximum yields if corn is grown continuously. (Project O-56 NE-11)

### **Eleven-Year Test for Grass Lines**

A number of breeding lines were found capable of high yields when grown following a tall fescue sod. The site had also been heavily limed 5 years ago. Differences between lines were compressed under these conditions.

Testing of named Maryland varieties

was continued for the eleventh year. Moore, a farmer's selection now rather widely accepted, Sweeny, and Long Red performed as well as Catterton or Posey, but none equaled Wilson in yield or value.

(Project J-59)

### **Heat Speeds Gas Treatment for Weed Seedling Control**

More rapid soil penetration by methyl bromide gas was obtained when the material was heated within the cans by immersion in boiling water before releasing the contents than when the cans remained at air temperature. The gas-tight plastic cover used to contain the gas could be moved after a few hours, instead of the usual 1-2 days.

Both gas treatments gave excellent

weed control and seedling growth. Drenches using vapam or mylone, both having the same gaseous active ingredient, N-methyl isothiocyanate, were improved in performance by covering the soil with sheet plastic after drenching. Eptam, a pre-emergence herbicide designed for use in vegetable production, was not safe or effective for tobacco seedbed use. (Project B-81)

## Irrigation Increases Response to Forage Fertilization

Forage fertilization and irrigation studies during the past four years have demonstrated the importance of adequate moisture if maximum response to forage fertilization is to be attained. This increased efficiency was most pronounced with high-nitrogen fertilization of pure grass stands. Adequate fertilization was found to be more important than supplemental irrigation in the maintenance of adequate forage stands.

Maximum forage production of Midland Bermudagrass and tall fescue was obtained with 400 pounds of nitrogen per acre while the bluegrass was able to effectively utilize only 200 pounds. The increase of alfalfa fertilization from 500 pounds of an 0-15-30 to 1,000 and 1,500 pounds resulted in small forage increases, with greater stand persistence under the higher fertilizer rates.

(Project BQ-83)

## Air Pollution Study of "Weather Fleck"

The occurrence of "weather fleck" of tobacco, a disorder in which the cells beneath the epidermis of the leaf are collapsed and die, leading to the appearance of numerous small lesions on the surface, has been correlated with high ozone levels in the atmosphere.

The Maryland station is cooperating with the U. S. Department of Agriculture and the Department of Commerce, Weather Bureau, in these studies, which are a phase of the general study of air pollution.

(Project BOQR-84)

## Long Rotations can Improve Tobacco Quality

Longer rotations can be expected to produce Maryland tobacco of higher quality than continuous tobacco with winter covers. Improved physical condition of the soil is believed to be largely responsible for the benefits. Increased compaction of the soil with continuous tobacco decreases gaseous ex-

change, and Maryland tobacco needs a well-aerated soil if a high-quality product is to be obtained.

Higher yields are not necessarily a product of longer rotations, but are obtainable if proper levels of plant population and fertilization are reached.

(Project B-68)

## Forage Crop Weed Control

The use of CIPC to control chickweed in pure alfalfa stands is an accepted practice. It now appears that this herbicide can be used at a rate of 1 pound per acre in seedling orchardgrass-alfalfa mixtures and at a rate of 1.5 pounds per acre in established orchardgrass. Brome, tall fescue, and timothy mixtures still require the use of

dinitro rather than CIPC. Research with pre-emergence herbicides continues, and to date it seems that EPTC and its analogs offer the best possibilities for control of weeds that germinate in the fall and reduce the quality of the first cutting. New herbicides are being added to these trials and several look very good.

(Project B-79)

## Study of Giant and Yellow Foxtail

The effect of shade on the growth of foxtails was studied in the greenhouse. It was found that 60 percent shade reduced the leaf width of giant foxtail. Both species showed a reduction in dry weight per plant. The number of tillers was also reduced by shade. These results indicate that shading in the field by crop plants may be a significant factor in lowering the vigor and competitiveness of foxtail.

When foxtails were treated with dalapon, seed production was reduced if the treatment was made just before heading. Clipping foxtail as a part of cultural operations may not be as effec-

tive as it appears. When foxtails were clipped at various stages, the only treatment that lowered head and tiller production was a single clipping at 41 inches.

Research also indicates that foxtail plants contain substances which directly inhibit germination of other seeds. This substance was extracted with water and subjected to freezing, boiling and centrifuging. None of these affected the activity. A cation exchange did not reduce the activity of the extract but an anion exchanger eliminated the effect.

(Project B-70)

## Improvement in Herbicide Technique

One of the problems involved in working with small quantities of herbicides in greenhouse flats has been partly solved by the construction of a sprayer for just this purpose. It is an enclosed ventilated unit within the greenhouse. The flats or pots are placed in the unit and a nozzle passes over the flats. The sprayer has been used to ascertain the relative efficiency of granular and liquid formulations of two herbicides on several weed species when applied pre-

emergence to the weeds.

Research was also continued this year on the triazine herbicides. It was found that in a petri dish in the laboratory soybeans will germinate and grow well in the presence of atrazine, whereas in the field atrazine kills soybeans. It appears that as long as soybeans are utilizing stored food materials the triazines are not active but will prevent manufacture of new food supplies.

(Project B-80)

## Control of Weeds in Cultivated Crops and Turf

Weed control in soybeans is becoming more and more important as the value of clean beans is more widely recognized. Many new materials have been tested and some have appeared to be promising. The most recent to be recommended is Amiben. It has been tested several years, and satisfactory weed control has been obtained with no injury to the beans. In corn the performance of Atrazine continues to be very good and it has replaced simazine almost entirely. Granular and spray

formulations appear to be equal in effectiveness. Cultivation after band treatment did not reduce the activity of Atrazine, but 2,4-D was dissipated. As a post-emergence treatment it was found that Atrazine was best used at a rate of 2 pounds per acre before the weeds are over 4 inches tall. Other herbicides were less effective and some injured the corn. Several herbicides continued to show promise in field-planted tobacco. Quality of the leaf was satisfactory and yields were not increased. Weed contro-

was best with EPTC, applied as a post-transplant treatment. Nutgrass in corn was most satisfactorily controlled with Atrazine applied when the corn was 6 inches tall.

Ground ivy, chickweed and henbit are becoming increasingly serious in lawn and turf areas. Research was continued on how best to control them. 2,4-D, 2,4,5-T and silvex controlled

ground ivy. Various forms of silvex were best for chickweed. Control of speedwell was best obtained with Zyttron. Crabgrass control by dacthal and Zyttron is still the best method. It was found that most crabgrass materials were toxic to grass seedlings until the plants were well established.

(Project B-78)

### **Summer-Annual Management Study**

Farmers using summer-annual pastures expect to get high yields of dry matter in a relatively short period. The dry-matter yield can be drastically affected by clipping and fertility management. This study has demonstrated that there is no response from very high rates of nitrogen fertilizer. It has also been shown that the new Sorghum-

Sudangrass hybrids produce best when allowed to attain a height of at least 30 inches before harvesting. Sudangrass and Pearl Millet are not so sensitive to early cutting as is the hybrid; however, all three do best when harvested to allow at least a 4-inch stubble.

(Project B-82)

### **Ragweeds Reduce Potassium Fixing Power**

Some of the answers of the differences in crop growth following a crop year of weeds are beginning to unfold at the University of Maryland. Researchers are finding that ragweed tends to reduce the potassium- and the

ammonium-fixing powers of soils. Other weeds and grasses vary in this effect, some being effective and others, such as orchardgrass, quite ineffective.

(Project O-57)

### **Nitrogen-fertilized Grasses Compared with a Grass-Clover Mixture as Pasture for Dairy Cows**

The use of nitrogen fertilizer on perennial pastures is becoming more widespread with the availability of economical sources of nitrogen. This opens the possibility of seeding pastures with grass only and omitting the more difficult-to-manage legumes. Results at the Forage Research Farm show that individual cow performance was better on grass-clover pastures than on orchardgrass pastures fertilized with commercial nitrogen. Dry-matter yields of forage and carrying capacity, however, were twice as high on pastures fertilized

with 200 pounds of nitrogen, as compared with the orchardgrass-clover pasture.

The sod-seeded rye and Midland Bermudagrass combination which had performed poorly in 1960 was managed to produce more succulent forage in 1961 by clipping closely and increasing the nitrogen application to 300 pounds per acre. The performance of this pasture in 1961 showed that under close management it can be a productive dairy cow pasture.

(Project BG-1)

## Productive Grass Stands Require Good Management

Pure stands of Potomac orchard, Pennlate orchard, Saratoga brome and reed canary were harvested at three growth stages in the spring and at two stubble heights during the 1959 growing season. This was carried out at two nitrogen levels. Making the first harvest at the early boot stage was outstanding in both yield and quality. Quality was greatly reduced with delayed harvests,

while early harvests reduced stands in the case of bromegrass. The height of stubble had little effect on the stands of orchard and reed canary, but bromegrass stands were reduced by severe clipping of the aftermath harvests. High nitrogen application greatly increased forage production but tended to reduce stands.

(Project B-73)

## New Pasture Systems Under Test

For several years experimental results have demonstrated that improved pasture combinations can substantially increase beef production. For example, the use of Midland Bermudagrass in which rye has been sod-seeded in the fall has produced over 700 pounds of beef per acre whereas the highest production from other recommended pastures has only been 400 pounds. The use of Kentucky bluegrass in conjunction with Midland and sod-seeded rye

appears to be even more productive and certainly more workable under a well planned full-season pasture program. This system was tested during the past year and found to be much more productive than a single cool-season mixture such as orchard-ladino. Such a system can produce continuous, uniform grazing for a period of 8 to 9 months rather than the usual 6 or 7.

(Project B-56-J)

## Permanent Pastures Supplemented with Sod-Seeded Annual Forage Crops

Summer-growing perennials such as Midland Bermudagrass must be supplemented during the late fall and early spring. This can be done with Kentucky bluegrass or orchardgrass-ladino clover on additional acres of land or it can be accomplished on the same land area by the technique of seeding annuals directly into the Midland sod. The latter practice substantially increases production per acre. Close row spacing, high seeding rates and high nitrogen rates have significantly increased fall yields, as well as spring production, of the annual species with-

out reducing the summer production of the Midland. (See Frontispiece). The sod-seeded combination of rye and vetch was superior to either species alone. Best results were obtained by sod-seeding around the first of October. Late November sod-seedings were not satisfactory.

Considerable progress has been made in developing suitable techniques for the establishment of small-seeded legumes into an existing permanent pasture where the legume has been lost.

(Project B-75)

## Seeking New Tests of Varietal Purity of Forage Seeds

The Northeast Region in general is a forage seed consuming area. Farmers must rely on certification or on the dealer, in the case of uncertified seeds, for varietal purity. Control officials must use long and involved testing procedures for trueness-to-variety determinations. By the time such tests are completed, the seed has been planted and the farmers may be due for a disappointing loss. Through this project, attempts are being made to locate quick tests to determine varieties of alfalfa.

The supporting work in the field is correlated with laboratory work being conducted at other Northeast stations.

The information obtained from this project has helped make it possible to determine the best criteria to use in evaluating field plantings. These findings will help in the long-range program of detecting admixtures of unadapted varieties. As a result, farmers should be able to rely more on the label as to variety.

(Project NEM-22)

## Corn Silage Grown under Varying Rates of Nitrogen Fertilization

The squeeze of higher costs has prompted farmers to look for ways to increase per-acre yields, and inasmuch as nitrogen fertilizer is now a more economical buy, the use of high nitrogen to boost yields warrants attention.

In this study, corn silage grown under low and high rates of nitrogen was compared from the standpoint of yield and feeding value. In most cases only slight increases in yield were obtained from rather costly nitrogen applications, and it thus appears that when the requirements of the plants have been met

there is no benefit from additional nitrogen. Excess nitrogen taken up by the plant is stored as nitrate, and this is given off as a poisonous gas during the ensiling period. While the gas is being given off, extreme caution must be taken to avoid breathing these fumes. The resulting silage from both high- and low-nitrogen corn appears to be the same in feeding value, with the evolution of gas acting like a safety valve to dissipate the excess nitrates.

(Project B-86)

## More Winter Hardiness Needed in Oats

Susceptibility to cold injury tends to limit the use of fall-sown oats. Even when planted at the proper time, the most hardy varieties sometimes freeze out in central Maryland. In the milder climate of Eastern and Southern Maryland many varieties come through satisfactorily when planted during late September and early October—earlier than necessary for barley, wheat and rye. Conflict with other farm operations, however, often causes late seeding of oats, with consequent reduction in survival. Therefore, varietal improvement is needed in regard both to ultimate

hardiness and to rate of development of hardiness.

A regional project is under way to provide better understanding of cold resistance, ways to measure it, and ways to get more of it into useful varieties. The Maryland Station is studying the development of cold resistance in seven varieties by means of successive field planting beginning about October 1. Plant survival in the field is being compared to laboratory freeze-tests and related to daily temperatures and other field conditions.

(Project B-85)

## Maximum Production

As a research tool, the concept of maximum production is useful because it encourages the worker to shed his innate timidity and "shoot for the moon." With that in mind, the present study was designed to measure the combined effect of large increments of several factors, all of which had a plus effect when used singly. Their effect when combined may be additive, may consist almost wholly of one dominant effect, or it may not be additive.

Of the factors originally proposed as variables, supplemental irrigation was used only as a corrective measure, and as that, was used infrequently. The dominant factor for 2 years of the test proved to be the increase in rate of nitrogen fertilization. Yield went up with each increment, 60, 90, 120, or

180 pounds per acre; price per pound was highest at 90 pounds; acre value highest at 180 pounds. Increased plant population was not effective. The use of a sucker inhibitor had a positive effect only at 180 pounds of nitrogen.

In 1960 the test was moved to a field whose cropping history included 2 years of soybeans and 3 years of a heavy stand of tall fescue. The fertility thus accumulated obliterated all other effects, and in itself tended to produce very high yields but uncertain quality. Nitrogen above the basic amount of 60 pounds per acre was either neutral in effect or detrimental at the higher levels. Only Catterton tobacco maintained a fair level of quality with increased nitrogen supply.

(Project B-87)

## Summer-Annual Grazing Study

Summer annual pastures are widely used throughout the eastern United States to provide grazing during periods when most perennial pastures are unproductive. Pearl Millet and Sudangrass have both been recommended in Maryland, but recent reports have shown that under some conditions butterfat production has been depressed when cows were pastured on Pearl Millet. Sudangrass-sorghum hybrids have been developed by several commercial seed companies and are receiving widespread attention.

It is important to dairymen in Maryland to have these pastures compared under actual grazing conditions, with

milking cows. A cooperative study between the Agronomy and Dairy departments comparing these three forages has been started at the Forage Research Farm and will be continued in 1961. With the grazing conditions of last-year cows pastured on Pearl Millet suffered a slight depression in butterfat production. Under farm conditions the danger of fat depression can be overcome by feeding hay or silage to cows pastured on this forage. The problem, however, needs further study. In 1960 the performance of the Sudangrass-sorghum hybrid was similar to that of Sudangrass.

(Project BG-2)

## Nicotine can be Storage Material

Studies on alkaloid transformation in tobacco plants fed with labeled alkaloids indicate that some of the  $N^{15}$  appears in free amino acids and some of

the  $C^{14}$  in sugars and organic acids. This indicates that the tobacco plant can utilize nicotine as a storage material and it is not just a waste product.

Studies on controlled fermentation of Maryland tobacco with several ambient temperatures show increased loss of ammonia and also weight loss with rise of temperature. An inverse relation with ambient temperature was found

for carbon dioxide production and temperature rise within the flasks.

Direct application of the fermentation studies is related to the use of Maryland tobacco by the cigar industry.

(Project B-89)

### **Summer-Annual Management Study**

A review of rainfall records in Maryland reveals that over the last 10 years only three summers were without drought periods. During hot, dry periods many farmers rely on summer annual pastures to carry their livestock when most other pastures are dormant. Management of summer annual pastures, however, is quite different from the management of perennial pastures, and there is generally a lack of information on when to begin grazing summer annuals, and how severely to graze them.

A study presently underway is designed to find out the best time to begin pasturing Sudangrass, Pearl Millet and Sudangrass-sorghum hybrid. Through his study it is also hoped to determine just how much stubble should be left

after each grazing, and how much nitrogen fertilizer will give the most economical results.

The first year's results seem to indicate that the greatest total yield over the season may be obtained by allowing about 24 to 30 inches of growth to be made before harvesting, and then leaving about an 8-inch stubble. Under grazing conditions, however, it is desirable to start grazing the forage before this much growth has been attained and sacrifice some total production for higher quality. It is important to leave enough stubble to insure rapid regrowth. Nitrogen response is inconclusive, based on 1 year's work, but Pearl Millet seems to respond more to higher nitrogen fertilization than does Sudangrass.

(Project B-82)

### **Kent and Bethel—New Soybean Varieties— Released to Maryland Farmers**

Two new soybean varieties of Group V maturity were released cooperatively with other states by the Maryland Agricultural Experiment Station. Kent is an exceptionally high-yielding variety with

good resistance to lodging and high oil content of seed. Bethel was released as a recommended soybean variety for areas infested with root-knot nematodes.

(Project B-43)

### **Chesapeake, DuPuits, Pilgrim, and Midland Red Forage Crop Varietal Parade**

Extensive testing of red and white clovers, alfalfas, and Bermudagrasses indicates that Chesapeake red clover, Pilgrim Ladino clover, Midland Bermudagrass, and DuPuits alfalfa are exceptionally good varieties within each the species. Evaluations of annual

grasses indicate a wealth of variability among sudangrasses, pearl millets, Johnsons grasses, sorghasses, sorghum alums, and sorghum-Sudangrass hybrids in regard to forage production, adaptability to pasture management, and disease resistance.

(Project B-77)

## Genetic and Breeding Studies in Red Clover

A large source nursery of red clover has contributed valuable clones for investigation of disease resistance and persistence. Inheritance studies on resistance to mildew and "pseudo-self-

fertility" are in progress. Two breeding methods are being investigated with this species in an attempt to produce more valuable varieties of red clover.

(Project B-76)

## Persistence and Breeding Studies Continue with Ladino Clover

Experiments concerning the improvement of Ladino clover as a persistent and productive pasture species were continued during 1960. These studies were designed to: (1) Determine fac-

tors affecting persistence, (2) isolate more persistent and desirable germ plasm, and (3) evaluate the possibility of producing true F<sub>1</sub> double-crosses with Ladino clover. (Project B-56-g)

## Evaluation of New Synthetic Varieties of Alfalfa, Bromegrass, and Orchardgrass Begins

New synthetic varieties of alfalfa, bromegrass, and orchardgrass are being evaluated under several systems of management in an effort to identify superior varieties of forages for Maryland and for the Northeastern Region

of the U. S. These tests include a Flemish variety of alfalfa that is resistant to bacterial wilt; early, medium, and late maturing orchardgrasses; and disease-resistant bromegrasses.

(Project B-56-i)

## Large Summer Yields of Midland Bermudagrass

High summer yields of a perennial forage crop are possible with Midland Bermudagrass. This grass has responded to nitrogen fertilization rates as high as 800 pounds per acre. The greatest economical return is between 200 and 400 pounds of nitrogen per acre. Crude protein of this forage has been increased by the high nitrogen fertilization. The quality of the forage has been improved with an increase in the number of harvests throughout the growing season, as

well as by the addition of nitrogen. Although the quality of the forage was enhanced with more frequent harvesting, total dry-matter yields were decreased. Higher yields were obtained when the forage was cut at a 1- or 2-inch stubble height rather than at inches. Although stands were slightly thicker with the higher stubble height, adequate stands were still present on all plots after two harvest years.

(Project B-74)

## Stalk Rot of Corn Receives More Attention

Along with vigor and productivity, the structural strength of roots and stalks has been improved through breeding. Not only do healthy plants stand

well, but also their ability to stay healthy has been increased. Despite general improvement in stalk-rot resistance, however, we still have to

much trouble with it in Maryland and elsewhere.

Because of this situation, Maryland and other northeastern states are cooperating to learn more about the disease, and to discover better sources of resistance. To this end a group of early and a group of late inbred lines and

their respective single-cross progenies were included in tests in Maryland. Although there was much inconsistency among the tests as to degree of stalk rot exhibited, a few lines seemed to transmit resistance to their progenies. They will receive more attention next year. *(Project B-50)*

## Effects of Soil Temperature on Forage Crop Growth Studied

In order to gain more specific information on the response of different forage species to a variety of soil temperatures, studies are being conducted in the field where only the soil temperature is controlled. This can be done in controlled growth chambers but it is very difficult to duplicate entirely those

conditions existing in the field. Pilot studies during 1960 have demonstrated that soil temperatures can be controlled in the 70° to 100° F. range. The facilities will now be used to test the response of various forage species grown in the temperature-controlled plots.

*(Project B-83)*

## Wheat Breeding and Evaluation

Although wheat continues to decrease in importance in Maryland, it still occupies an acreage almost as great as that of all other small grains combined. Apparently, through its several uses, it finds a place on many farms.

Experimental strains from various sources are compared annually. A collection of mildew-resistant crosses are in the final stages of evaluation. Varieties

differ in response to fertility. In 1960 on experimental plots, grain and straw yields for Seneca, Pennoll, Tayland, and Knox varieties were increased from 35 to 42 percent by spring top-dressing with 30 pounds of nitrogen per acre. Untreated and treated plots averaged 27.6 and 44.1 bushels of grain per acre respectively.

*(Project B-66)*

## Testing Split Applications of Fertilizer to Crops

Studies of applications of fertilizers to corn indicate that a split application of 1000 pounds of a 10-7.25-10 was superior to a single application in any of the following forms: (1) Through split boot, (2) banded 2" to side 2" below seed, (3) broadcast and plowed down, and (4) broadcast on the surface and disked in. When 800 pounds of the 1000 pounds of 10-7.25-10 fertilizer was broadcast and plowed down and the last 200 pounds was applied, either through the split boot or banded 2" to

side and 2" below the seed, yields were improved over single application by some 11 to 20 bushels.

Alfalfa's remarkable ability to remove large quantities of fertilizer elements from the soil is often stimulated by inadequate applications of fertilizer. This plant then becomes a potash and phosphorus soil-depleting crop. Soil depletion is not always reflected in yields; in fact, yield may remain nearly the same even though at times the plant contains less than sufficient levels of

potassium and phosphorus. This entire process may be overcome by sufficient

fertilizer applications.

(Project O-62)

## Soil Test Studies

A new and different test for determining the cation (i.e., calcium and/or ammonium or potassium megnesium, etc.) retentive powers of soil has been developed at the University of Maryland. The test not only indicates the total sum of materials that may be held but also shows how tightly the materials

are retained. The test can be used in the identification of soil clays and soil horizons.

These latter features make test results useful in soil correlation studies, enabling correlators to determine if similar-appearing soils are actually the same.

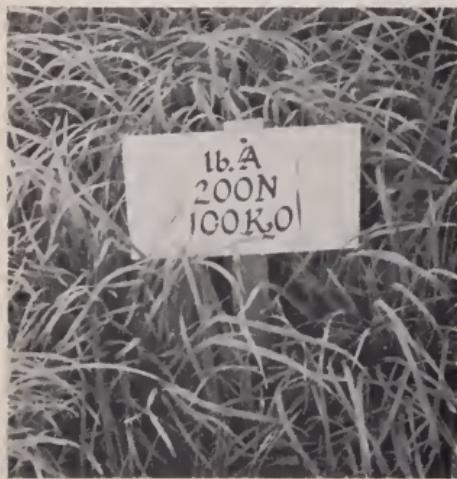
(Project O-55)

## Nutrient Balance in Orchardgrass Critical for High Yields

Just as our bodies require a certain nutrient balance, so do plants. Among plants, various species and even varieties within species differ from one another in this respect. A study of the plant requirements for the major fertilizer elements—nitrogen, phosphorus, and potassium—is one of the first steps in producing maximum yields. Three years of data from a long-term experiment indicate that a 1.5-to-1 ratio of nitrogen to potash is necessary for maximum orchardgrass yields. When pure orchardgrass is grown for several years in a forage program, the requirements

for applied nitrogen will not vary much from year to year. Somewhere between 150 and 200 pounds of nitrogen per acre, applied in split applications seems to be most economical. On the other hand, the requirement for applied potassium can vary considerably, depending upon the ability of the soil to supply potassium. The needs of the orchardgrass will not change appreciably, but the percent of that requirement which must be supplied by applied fertilizer will tend to increase if the soil has a high potassium supplying power initially.

(Project O-59)



Two hundred pounds of nitrogen increased orchardgrass yields (right) from 1.66 to 4.5 tons of dry matter per acre when the proper amount of potash was applied.

## Fall Versus Spring Applied Nitrogen

The element of time is of utmost importance to today's farmer. He is constantly aware of opportunities by which he can better distribute his workload over a year's time. If nitrogen can be applied to forage grasses in the fall with comparable results to spring-applied nitrogen, his heavy spring workload can be reduced. The effectiveness of fall- or spring-applied nitrogen can be affected by the source of nitrogen used. Leaching and volatilization losses of certain nitrogen sources can be quite

large under certain conditions. To study this situation, various rates of several nitrogen sources (urea-formaldehyde, urea,  $\text{NH}_4\text{NO}_3$ , and  $(\text{NH}_4)_2\text{SO}_4$ ) will be fall and/or spring applied to a pure orchardgrass stand. These treatments will be repeated for several years to take into consideration the effects of different climatic conditions. Effectiveness of nitrogen fertilization will be evaluated on the basis of yield and quality of forage.

*(Project O-63)*

## Use of Urea-Formaldehyde on Bluegrass Forage

Grasses have a high nitrogen requirement during the entire growing season. Split applications of easily soluble nitrogen sources are necessary to keep the grass supplied with nitrogen. Urea-formaldehyde is a slow-releasing form of nitrogen. Can a single annual application of urea-formaldehyde compare favorable with more soluble nitrogen sources when applied to bluegrass for forage? Results of a three-year experiment indicate that at rates of nitrogen currently in use (up to 160 pounds of nitrogen per acre), urea-formaldehyde, urea,  $(\text{NH}_4)_2\text{SO}_4$ , and  $\text{NH}_4\text{NO}_3$  can be

used with equally satisfactory results in a long-range bluegrass pasture program. There are two compensating qualifications in this conclusion: (1) Urea-formaldehyde needs to be applied only once each year, as compared to twice or more for the more available nitrogen sources, and (2) urea-formaldehyde must be supplemented with about 25 percent of the nitrogen from a more available source. Unfortunately, the cost of urea-formaldehyde continues to prohibit the use of this material on a large scale.

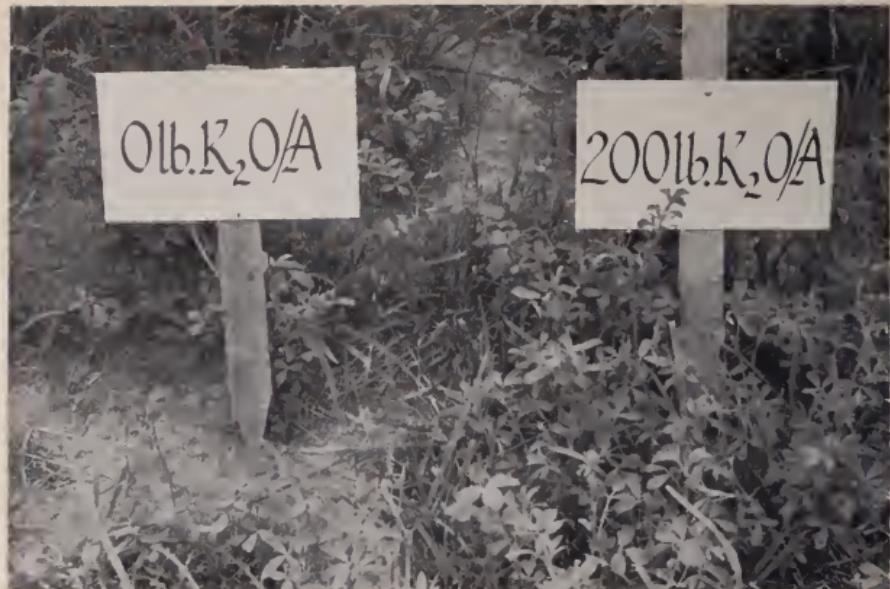
*(Project O-61)*

## Good Bermudagrass Forage Requires Nitrogen

Midland Bermudagrass is a fast-growing, hot-weather plant which produces large tonnages of forage when properly fertilized and managed. The fertility requirements of Bermudagrass at the northern extreme of its practical cultivation are not too well known. Various rates and ratios of nitrogen and potassium were topdressed on such a stand in 1960. The lowest rate of nitrogen with which maximum yield was obtained was 400 pounds per acre. Dry natter yields for nitrogen rates of 200,

400, 600, and 800 pounds per acre were 5.7, 6.9, 7.3, and 6.8 tons per acre, respectively. Very little response to potash was observed, indicating that the soil was capable of supplying enough potassium for maximum yields during the first year. This investigation will continue for several years in order to properly evaluate the optimum rate and ratio of nitrogen and potassium to apply to Bermudagrass for maximum yield and stand persistence.

*(Project O-64)*



A liberal application of potash each year is necessary to maintain a healthy alfalfa stand.

### **Potash Critical for High-Yielding Alfalfa Forage**

Potassium requirements for alfalfa and alfalfa-orchardgrass mixture are similar. Although dry matter yields of the mixture are slightly higher than for alfalfa alone, 200 pounds of potash per acre, applied annually, is sufficient to meet the needs of both systems. An annual application near 200 pounds of potash per acre is also necessary to maintain the alfalfa stand. The time of year at which the potash is applied is not of great importance in the heavier-

textured soils of the Piedmont Plateau of Maryland. In this region, results of a three-year experiment indicate that the percent of potassium in the alfalfa plant critical for maximum yield ranges from 1.75 to 2.00, the level being lower in the first two cuttings of the year than in the last two cuttings. The critical level for the alfalfa-orchardgrass mixture was slightly higher than that for alfalfa, but only in the first two cuttings.

(Project O-60)

### **Barley and Oats Improvement**

Winter barley, winter oats and spring oats altogether occupy annually about 140,000 acres of cropland in Maryland. These crops are used mostly for feed, principally on the farms where grown. All have geographic limits within the state, because of their respective climatic and soil requirements. All are subject to damaging diseases.

Much has already been done in the

breeding of new varieties with better temperature tolerances, better disease resistance, and better seed and plant characteristics. At present, special effort is being directed toward further improvement in mildew resistance and head type in barley, more cold tolerance in winter oats, and more straw strength and overall productivity in all three crops.

(Project B-67)

## ANIMAL HUSBANDRY

Practical animal husbandry involves the use of knowledge gained through research, and certain arts of the producer. Responsibilities of researchers in animal husbandry include application of concepts and techniques of basic sciences, reducing where possible the arts of the producer to an objective basis, and also testing some of the prevalent, untested concepts and lores of the field. Research undertaken by animal husbandmen is initiated with the intent of obtaining information which may be of immediate or eventual economic importance.

### A Comparison of Roughage-Grain Ratios for Developing Beef Heifers

The proper development of replacement heifers is a major concern to all beef cattle producers. On our beef cattle farms today, replacement heifers range in condition from thin to very high. Also, because of the plane of nutrition in the developing stage, they vary widely in size, and thus influence the age at which reproduction should take place.

During the past 10 years, all University of Maryland's purebred Angus and Hereford heifers have been on a feeding test from weaning for approximately 200 days, in which the plane of nutrition has been high. Replacement heifers have been selected at the end of the feeding tests. How this has affected the usefulness of these heifers is not known. Among many producers there exists the opinion that the future usefulness of highly fitted cattle is impaired. Comparison at the University of Maryland could not be made between different planes of nutrition, because no replacement heifers have been developed under a lower plane of nutrition. A test was started in the fall of 1960 in which heifers would be fed on different levels of concentrates to study their growth and development. In addition, this would provide re-

placement heifers developed on varying planes of nutrition for future studies of productivity and longevity.

Sixteen Angus and 11 Hereford heifers from the University herds were weaned in October 1960 and started on the feeding trial. They were on the feed test for 196 days. The heifers were divided into four lots as uniformly as possible with reference to breed, age, weight, and condition. All lots received a ration of coarsely cracked U. S. No. 2 corn, soybean oil meal, and U. S. No. 1 alfalfa hay. Hay was fed free choice. The concentrate was fed twice daily as follows: Two lots were fed 1.5 pounds per hundred pounds live weight and two lots 1.0 pound per hundred pounds live weight. The amount of concentrate fed was adjusted for each lot at the start of each 28-day period. Cattle were weighed each 28 days while on test and the average weight of the lot was calculated at that time. The amount of soybean oil meal added was that needed to balance properly the ration for protein.

Heifers fed 1.5 pounds of grain per hundredweight, gained 1.77 pounds per head per day versus 1.47 pounds for those fed 1.0 pounds of grain per hundredweight. Eleven heifers (7 Angus

and 4 Hereford) were selected for breeding purposes. Of the 7 Angus heifers selected, 5 were from the lots fed 1.0 pounds of grain per hundredweight; of the 4 Hereford heifers selected, 3 were from the lots fed 1.5 pounds of grain per hundredweight. The remaining 16 heifers were slaughtered; 8 heifers from each of the different nutritional planes.

Carcass data for the slaughtered heifers are as follows: The average slaughter-

ter weight, cold carcass weight, dressing percent, and square inches of rib-eye respectively for heifers fed 1.5 pounds of grain per hundredweight were 785, 495, 63.1, 9.87. Data for heifers fed 1.0 pounds of grain per hundredweight, were 696, 419, 60.2, 9.45. Heifers fed 1.5 pounds of grain per hundredweight produce carcasses grading on the average, "Average choice," versus "Low choice" for those fed 1.0 pound of grain per hundredweight. (Project C-37)

### **Crimped Barley Shows More Profit Than Pelleted Barley for Beef Calves**

A two-year study on the feeding of crimped barley versus pelleted barley to beef calves indicates that it would be less profitable to pellet barley for feeding beef calves.

Feeding trials, comparing crimped and pelleted barley for growing and finishing weanling beef calves, were carried out for 2 years (1958-60). Seventy-six (33 heifers and 43 steers) purebred Angus and Hereford creep-fed calves from the University's herds were used in these feeding trials. Heifers were used only the first year (1958) of the trial. All calves were put in the feed lot at weaning time. In 1958, calves were weaned on October 7; in 1959, on October 6. Heifers were fed for 196 days and steers for 252 days, post-weaning. All steers were implanted with 36 mgs. of Stilbestrol one week after going on test.

The calves were divided into as uniform lots as possible by breed, sex, age and weight. They were approximately 8 months of age at the start of the feeding tests. Steers averaged 487 pounds in weight and the heifers 465 pounds at the start of the trial. The ration fed consisted of barley, protein supplement, alfalfa hay, and minerals. Approximately one-half of the cattle received crimped barley and the other

half were fed pelleted barley. The protein supplement (soybean oil meal) was pelleted in with pelleted barley except that one heifer lot was fed a liquid protein supplement; also one heifer lot fed crimped barley received the liquid protein supplement. The amount of soybean oil meal added was that needed to balance the ration for protein. All feeds were fed free choice.

Heifers fed crimped barley gained 1.67 pounds per head per day, consumed 12.66 pounds of concentrate and 4.03 pounds of hay per head per day, required 10 pounds of feed per pound of gain, and the gains cost \$28.57 per hundredweight. The pelleted barley group gained 1.64 pounds per head per day, consumed 12.37 pounds of concentrate and 5.06 pounds of hay per head per day, required 10.7 pounds of feed per pound gain, and the gains cost \$30.96 per hundredweight. Thus the feed cost for the heifers fed crimped barley was \$2.39 less per hundredweight gain, which resulted in \$7.84 more profit per heifer.

In 1958 and 1959 steers fed crimped barley had an average daily gain of 2.04 and 2.03 pounds versus 1.89 and 1.97 pounds for the pelleted barley group. The average daily gain for the two trials for steers fed crimped barley

was 2.03 pounds versus 1.93 pounds for the pelleted barley group. For the two trials, steers fed crimped barley consumed 13.67 pounds of concentrate and 4.27 pounds of hay per head per day and required 8.9 pounds of feed per pound of gain versus 12.99 pounds of concentrate and 5.45 pounds of hay per head per day, and required 9.6 pounds of feed per pound of gain. Feed cost for the steers fed crimped barley was \$25.09 per hundredweight versus \$27.77 for the pelleted barley group. The feed cost was \$2.68 less per hundredweight gain for steers fed crimped barley which amounted to a profit of \$13.72 more per steer.

Combining the steers and heifers for the two years, the average daily gain for cattle fed crimped barley was 1.90 pounds versus 1.82 pounds for those

fed pelleted barley. Daily feed consumption for the study for cattle fed crimped barley was 13.29 pounds of concentrate and 4.18 pounds of hay, versus 12.76 pounds of concentrate and 5.30 pounds of hay for the cattle fed pelleted barley. Feed required per pound gain for the cattle fed crimped barley was 9.3 versus 10.0 pounds for the pelleted barley group. Feed cost for the crimped and pelleted barley group was \$26.24 and \$28.8 per hundredweight, respectively. This amounted to \$2.60 less per hundredweight for cattle fed crimped barley and a profit of \$11.23 per animal.

The extra cost of pelleting the barley, the increased hay intake, and slower rate of gain resulted in higher feed cost per hundredweight gain for cattle fed pelleted barley. (Project C-31-a)

## Urea Supplements Tested

Urea is often the most economical source of potential protein available to feeders of ruminant animals. Studies investigating the use of urea with low protein-high fiber roughages have been initiated. A concentrate mixture made up of corn, molasses and urea and used at a level to supply 0.8 pound of TDN per 100 pound of livestock, plus 0.2 pound of urea per head per day was fed to weaned beef steer calves. The concentrate was fed twice a day to one group of calves, and a second group was fed eight times per day at 2-hour intervals from 6 a.m. to 8 p.m. Sudangrass silage was fed free choice. The frequency of feeding did not affect silage consumption or rate or efficiency of gain. Average daily gain, concentrates, and silage per 100 pounds gain were 1.35, 550, and 1272 pounds, and .34, 556 and 1262 for the twice-daily and frequently-fed groups, respectively. The Sudangrass silage was not palatable

and consumption did not exceed 20 pounds per day with 500-600 pound cattle.

Liquid supplements were mixed as follows:

Supplement	1	2	3	4
Water, lbs.	5.0	4.0	4.5	4.5
Molasses, lbs.	5.0	4.0	4.5	4.5
Urea, lbs.	—	1.0	1.0	—
Propionic Acid, lbs.	—	1.0	—	1.0
Ground Limestone, lbs.	1.0	1.0	1.0	1.0

Each of the above supplements was fed free choice to a group of lambs receiving pelleted orchardgrass hay. Average daily gains and pellet consumption in pounds for lambs in the four groups were: (1) 0.25, 1.66 (2) 0.33, 2.59 (3) 0.41, 2.74 and (4) 0.27, 2.25, respectively. These results indicate that propionic acid depressed palatability of the supplement so that protein intake was depressed. The "control" supplement (1) was quite palatable but the molasses intake resulted in a depressed pellet consumption, and the low rate

of gain is probably due to insufficient protein intake. Supplement 3 was consumed at a level which provided approximately 12.5 percent crude protein in the total diet and resulted in the highest pellet consumption and the

most rapid rate of gain. These results indicate that satisfactory low-cost urea molasses supplements can be prepared for feeding with low-protein roughages.

(Projects C-21 and C-36)

### Effects of Pelleting Hay Studied

As reported last year, feeding tests comparing ground, pelleted hays with long hays have shown that pelleting reduces the amount of hay required to satisfactorily nourish ewes in the latter weeks of pregnancy. Three pounds of pelleted alfalfa or alfalfa-orchard grass hay per ewe per day were equal to a calculated intake of 4.2 pounds per day of long alfalfa hay for maintaining weight gains and condition in pregnant Southdown ewes averaging 120-140 pounds in bodyweight. According to accepted feeding standards, such ewes should require 2.0-2.2 pounds of total digestible nutrients (TDN) per day, a quantity expected to be supplied by 4.2 pounds of good-quality hay. Results with pelleted hays suggest the possibility that the net energy value of the hays may be increased by grinding and pelleting.

The effect of pelleting upon rumen volatile fatty acids (VFA) was also studied. The most significant changes in rumen VFA due to pelleting were the increases in total VFA concentrations. The concomitant increase in rumen propionic acid and the slight increase in molar per cent propionate cannot be construed as evidence that total propionate production on pelleted diets exceeded that on long-hay diets. In fact, in light of evidence that the digestibility of hay is not appreciably affected by pelleting and the failure to demonstrate significant changes in the molar ratios of propionate and acetate, it must be concluded that the 24 hour production of propionate in ewes con-

suming 4.2 pounds of long hay exceeded that in ewes consuming 3.0 pounds of pellets. However, it has also been observed that the relative rates of absorption from the rumen of propionic and higher acids appreciably exceed the rate of acetate absorption, especially when total VFA concentrations are high (160-2000 M/ml). If this be the case, propionate was being rapidly absorbed at the time of sampling and rumen VFA may not accurately reflect the rates of production. Thus it is possible that propionic acid production was greater than the results of this study indicate.

Total rumen VFA concentrations do indicate the rate of ruminal fermentation or digestion at the time of sampling, and it may be concluded that pelleting increased the rates of digestion. Numerous reports in the literature show that rate of digestion or rate of passage but not percent digestibility is increased by pelleting roughages.

To study more precisely the effects of hay preparation and quantities consumed upon rumen VFA, ewes were individually fed alfalfa as long hay, as meal or as pellets at levels of 70 or 140 percent of the calculated maintenance requirements.

The high level of feeding resulted in increased concentrations of total VFA in the rumina of pellet or meal fed sheep. Quantities of long hay consumed did not significantly affect rumen VFA concentrations; low VFA concentration in sheep fed at the higher level suggests a slow rate of digestion for the long

hay. Molar ratios of the various VFA were not significantly (p. 7.05) affected by hay preparation or level of feeding. Rates and ratios of VFA production *in vitro* also failed to show differences due to hay preparation. There is nothing in these results which suggests that the grinding or grinding and pelleting of hay affects the manner in which the dietary constituents are fermented in

the rumen, and thus the VFA analyses do not suggest differences in energy values due to grinding or pelleting. The fact that rumen VFA data do not allow the conclusion that pelleting increases the nutritive value per unit of hay supports the observations that coefficients of digestibility or energy retention are not increased by pelleting.

(Project C-25-a)

## Experimental Bloat Produced by Drugs

Variations in susceptibility to bloat and in severity of bloat among and within animals suggest that this vari-



Sheep fitted with gas-tight rumen cannula made from a polyethylene bottle and a rubber compression plug designed for vacuum bottles.

ance represents varying degrees of inhibition of eructation. Bloat may be caused by ingested material(s) which primarily affects the autonomic nervous system either directly or as a result of some series of reactions. Studies designed to test the effects of drugs which control the autonomic nervous system and which may be linked with materials in "bloat" diets have been initiated. A physiological explanation for bloat is being sought and experimentation has been aimed at the more probable mechanisms which may be involved.

Ruminants were simultaneously injected with epinephrine (adrenaline) and atropine. Forty-two cases of bloat, thirty-nine in sheep, two in cattle and one in a goat, were produced using these drugs in dosages ranging from 0.09-0.24 Mg/kg/hr of adrenaline and 0.87-7.0 Mg/kg/hr of atropine. High levels



Parts of the rumen cannula in an exploded view. The cannula made from these inexpensive materials will give a satisfactory gas and liquid tight seal for 90 to 120 days. The cannula will permit the entrance of a tube up to 22 mm. in diameter.

of each drug alone produced bloat but side effects not usually associated with bloat were also produced.

Sheep pastured on alfalfa were used in studies to determine the similarity between the experimentally produced bloat and the natural phenomenon. Three sheep which showed slight bloat after grazing for 2.5 hours on alfalfa were injected with adrenaline and atropine and severe bloat resulted. Two animals showing no bloat after grazing were similarly injected and one bloated moderately. Thus, the linkage between the natural and experimental bloat is supported by demonstration of an additive effect.

The possibility that some materials

occurring in green legumes may affect the autonomic nervous system is being investigated. The feeding of L tyrosine (1-5 grams in the sheep) replaced epinephrine in the experimental production of bloat. Tyrosine is known to be present in the protein of legumes and is readily decarboxylated in acid fermentations to produce tyramine which is known to have an adrenaline-like effect. Some of the alkaloids which exist in legumes are known to exert atropinelike effects upon the autonomic nervous system. Preliminary work with alkaloid extracts of alfalfa and clovers indicate that these extracts will replace atropine in the experimental production of bloat.

(Project GC-45)

## **Appetite Inhibitor Not Practical in Swine Rations**

Consumers are indicating a desire for pork cuts with less fat. Many hog buyers are also recognizing the higher value of swine that yield a high percentage of their live weight in the four lean cuts (ham, loin, picnic and Boston butt) and offer a favorable price differential for high-yielding hogs. As the price premium becomes available, more producers are interested in feeding methods as well as breeding programs that will improve the quality of the pork carcasses which they produce.

Previous experiments at Maryland have indicated that the restriction of energy consumption by approximately 20% resulted in the production of the same amount of lean cuts in the same amount of time, but backfat thickness and leaf fat weight were reduced. A greater percentage of the live weight was represented in lean cuts and the efficiency of feed utilization was improved.

The restriction of energy consumption requires some method of limiting feed intake. Manual or mechanical

methods involve considerable cost. Therefore, the incorporation of an appetite inhibitor into the swine ration has been studied as a method of limiting feed intake and consequently, energy consumption.

The effect of three feeding methods on rate of gain, feed efficiency, and carcass characteristics has been investigated. Control pigs were placed on full feed. Hand feeding to restrict energy consumption by 20% was a second method. The third method was the inclusion of an appetite inhibitor in the ration and allowing the pigs to eat as much as they wanted. All pigs were on experiment for the same amount of time.

Although the limited hand fed pigs gained less weight, approximately 1.25% more of their weight was in the four lean cuts and the backfat thickness was reduced by 0.17 of an inch. The control pigs which were on full feed required more feed per pound of gain than the hand fed pigs.

The incorporation of an appetite in-

hibitor into the ration did not substantially improve carcass characteristics. Feed consumption was lowered somewhat for a period of 2 to 3 weeks, but following this period it returned to a level nearly equal to that of the control pigs. The efficiency of feed

utilization was significantly reduced when the appetite inhibitor was included in the ration, which indicates that this method of restricting energy consumption will not be practical.

*(Project C-26)*

### **Studies Begun on Suckling Pigs**

Studies have been initiated to evaluate different methods of creep feeding for suckling pigs. Observations have been made on a number of factors during the first 5 weeks of the lactation period. A pelleted, 16 percent protein creep ration was formulated to supplement the sow's milk supply. It contained corn, rolled oats, soybean oil meal, dried skim milk, condensed fish solubles and vitamin, mineral and antibiotic supplements.

Automatic watering devices connected to 1 gallon jugs were placed in the creep area for 18 of 34 litters. The standard creep ration and water were placed in the creeps when the pigs were 3 to 5 days old.

There did not appear to be any association between the availability of wat-

er in the creep area and such factors as pig growth, sow feed consumption and 5 week pig weaning weights. In some instances, earlier consumption of creep feed was observed when water was available in the creep area. This resulted in heavier pigs at 3 weeks of age.

It was noted that baby pigs consumed water at an earlier age than they began to eat creep food. This behavior provides for medication or supplying soluble supplements when the pigs are not yet consuming dry feed. The average water consumption per litter in the creep area was approximately 10 gallons for the 32 day period when water consumption was measured.

*(Project C-28)*

## BOTANY

The Department of Botany is committed to applied and fundamental research, as related to agriculture in Maryland. As may be noted in the following reports of research activities in the Department, certain of the projects are concerned with and contribute to both the fundamental and applied aspects of agricultural problems.

### Plant Identification

Plant specimens are received at all times of the year from all parts of the state, often through county agents or from other specialists. Typical questions are "What is it?" "Is it poisonous?" "How can I use it?" "Where can I buy

another?" "How can I get rid of it?" By using technical books and the specimens in the Experiment Station Herbarium, nearly every specimen can be identified.

(Project F-12)

### Twining May be Key to Better Tree Species

Previous work with the garden pepper had shown the practicability of isolating haploids from twin seedlings and subsequently doubling the chromosome number of the haploid to produce a true breeding diploid. This technique would make immediately available true-breeding lines which would otherwise require 7 generations of self-pollinating in a conventional plant-breeding program. It was felt that the extension of this technique to forest-tree breeding might be fruitful in view of the long interval between generations.

Earlier work with mimosa had established the fact that twins did occur in this species. It was then felt that it was desirable to see how widespread this

phenomenon was. Since woody legume seeds are relatively easy to germinate, ten different genera were selected and seeds from one species in each genus studied.

All of these species germinated much more quickly after a treatment with concentrated sulfuric acid for periods ranging from 30 minutes to 4 hours.

Twins were found in 9 of the 10 genera studied. Possibly a different species or strain of the same species would have yielded twins in the tenth genus.

It would appear that the phenomenon of twining is as widespread in tree species as it is in herbaceous species.

(Project F-17)

### X-Ray Induces Genetic Changes

The carriers of the heredity factors, the chromosomes, occur in pairs in most plants. One member of each pair is derived from the female parent, and

the male parent also contributes one of each kind of chromosome. Prior to the formation of the sex cells, the two like chromosomes must be associated or held

together in order to be distributed in the normal fashion of one of each type of chromosome to a sex cell. Failure of association, technically known as asynapsis, results in sterility.

It is well established that many different types of genetic change can be induced by X-rays. Pepper plants from seeds developed following X-ray treatment of the pollen were studied in regard to the association of like chromosomes. The X-rays induced hereditary changes which blocked normal association in two plants from different levels

of treatment. Detailed studies of the pollen mother cells disclosed that the asynaptic plants differed in degree of failure of association. The plant developed from the cross utilizing pollen treated with 2000r was highly asynaptic; moderate asynapsis occurred in the plant isolated from the 500r treatment. The plants exhibiting X-ray induced asynapsis will be useful for basic studies on factors concerned in the essential process of association of like chromosomes in normal, fertile plants.

(Project F-18)

### **Maneb Most Effective Spray for Tomato Diseases**

Tests of various fungicidal sprays for control of foliage diseases of vegetables indicated that maneb continues to be the most effective fungicide for control of tomato diseases. Maneb and phaltan plus sticker gave excellent control of anthracnose of fall cucumbers. Phaltan plus sticker gave outstanding control of *Alternaria* leaf spot of cantaloupe without any evidence of phytotoxicity.

In studies of the mechanisms of fungicidal action, it was shown that -SH enzymes isolated from cells treated with toxic doses of captan are inactive. Dodeine, glyodin and nystatin at or near lethal concentrations alter permeability of fungal membranes. Cycloheximide inhibits protein synthesis, but does not affect many other processes in fungal cells.

(Project J-91)

### **A Systemic Nematicide that Controls Tobacco Aphids**

The nematicide zinophos O, O-diethyl O-2-pyrozinyl phosphorothioate when applied to soil as a preplant, side dress or band treatment on tobacco has been found to be systemic. The chemical enters the plant in quantities

high enough to give good control of aphids up to harvesttime. It has not been found in dried cured tobacco. Zinophos also gives moderate to good control of root knot on tobacco.

(Project J-93)

### **Tobacco Selections with Resistance to 3 Diseases.**

The black shank varieties Mor 59 and Mor 609A have a high degree of resistance to *Phytophthora parasitica* var. *nicotianae*. When both selections were indexed for fusarium wilt resistance they were equally resistant to the disease, averaging about 80 percent in greenhouse tests. However, when both

varieties were indexed for black root rot resistance, only the Mor 59 gave a high degree of resistance to the fungus *Thielanopsis basicola* causing black root rot. Mor 59 resistance was 79 percent, while Mor 609A was 46 percent and susceptible control 15 percent resistant.

(Project J-95)

## Plant-Nematode Interactions

Studies on monoxenic culturing of plant-parasitic nematodes using alfalfa tissue cultures have led to improved media and methods for propagating nematodes in large numbers. Attempts are in progress to propagate additional nematode species by this means.

Parasitism of alfalfa seedling shoots by the stem and bulb nematode, *Ditylenchus dipsaci* during the initial stages of infection, was investigated. Nema-

todes penetrated through the shoot epidermis into cortex subtending cotyledonary axils within 12 hours after inoculation. After 24 hours, infected tissues were swollen and many cortical cells were destroyed. It is postulated that plant-growth hormones are mainly responsible for the disease symptoms caused by this nematode.

(Project J-97)

## Mosaic Virus Disease and Control, Effect on Tobacco Grades

Field tests on tobacco mosaic virus to determine its effects on tobacco grades indicate that weather conditions may determine the amount of loss due to mosaic. Posey variety was used. In 1959, rainfall in June, July, and August was sufficient to produce continuous growth throughout the season. Growth was, however, slower toward the end of the season, allowing the mosaic to keep pace with growth. In 1960 growth was slow, up to the last few days of July and early August, when late rains caused a very rapid growth of the plant. Tobacco mosaic virus was unable to keep pace with growth, thus lessening the effects on plant growth. The weather conditions are reflected in the loss due to mosaic in both years.

In 1959 there was a heavy loss in pounds per acre, 46 percent in bright crop leaf, 17 percent in seconds, 1.3 percent in dull bright, 11 percent in dull, and 2.5 percent gain in tips. In 1960 there was no loss in bright leaf, 20 percent in seconds, a 9 percent gain in dull bright, a 12 percent gain in dulls, and 30 percent gain in tips. Tips are a small part of the total pounds of tobacco per acre; losses here are negligible. Total loss per acre in 1959 was 19 percent of crop, and in 1960, 0.5 percent. The dollar loss in 1959 was 25 percent, in 1960, 4.2 percent. However, the total loss to the grower for the 2-year period was \$218 per acre, a considerable amount.

(Project J-98)

## Control of Root Rots in Decline of Boxwood

Factors which have been found to play an important role in the decline of boxwood in Maryland are: (1) Extended dry periods during the growing season, (2) lack of fertilization, (3) poor drainage, (4) location of plantings, (5) and winter injury. Any of these factors will reduce the host vigor thereby predisposing the plant to nema-

tode injury and eventual death.

Since nematodes can be an important factor in the decline and death of boxwood it is desirable to develop new nematicides which are easier to apply, are less expensive, and have a longer residual effect. Several of these experimental materials have been tested on established boxwood plantings on the

Eastern Shore. Vinyl pyridine and Dow ET-383-2 failed to control nema populations at the rates applied. D-D was extremely phytotoxic to boxwood. Am. Cyan. 18133 reduced the numbers of *Rotylenchus* at both the 20 and 60 lb./A. rates of 5 percent granular formulation and reduced *Pratylenchus* pop-

ulations only at the higher rate with no phytotoxicity. Dow M-948 (emuls. EDB) reduced both *Rotylenchus* and *Pratylenchus* at 36 ml./plant but was phytotoxic at 72 ml./plant although all nematodes species were nearly eradicated.

#### Parasitic nematodes associated with boxwood decline in Maryland:

*Aphelenchoides* sp.  
*Ditylenchus* sp.  
*Helicotylenchus multicinctus*  
*Hemicyclophorus* sp.  
*Hoplolaimus coronatus*  
*Hoplolaimus uniformis*  
*Paratylenchus penetrans*  
*Pratylenchus penetrans*  
*Rotylenchus buxophilus*

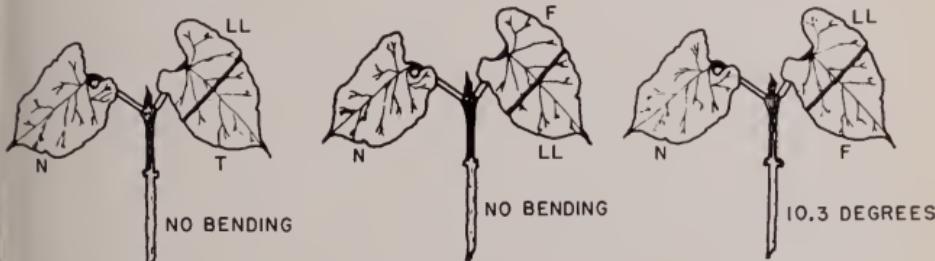
*Trichodorus parvus*  
*Trichodorus porosus*  
*Trichodorus primativus*  
*Tylenchorhynchus claytoni*  
*Tylenchorhynchus dubius*  
*Xiphinema americanum*  
*Xiphinema diversicaudatum*  
*Pratylenchus pratensis*

(Project J-99)

#### Effects of Leaf Sugars on Movement of Growth Regulators

Estimating the concentration of sugar in bean leaves by paper chromatography, it was found that 2,4-D did not move from a primary leaf, where it was applied, when the concentration of sugars was 0.1 percent (dry wt.) but did so when the sugar concentration in

the leaf was 0.3 percent. In using a conventional chemical method to determine "reducing power" (interpreted as sugars) in leaves, it had been reported that 2,4-D did not move from a treated leaf when it contained less than 2 percent "sugar". Presumably, therefore,



Diagrammatic representation of carbohydrate-depleted bean plants, in the dark, showing the dependence of 2,4-D movement on sugar movement. "N", no treatment; "F", 10 percent fructose solution in 0.1 percent Tween 20; "T", 0.1 percent Tween 20; and, "LL", low level of 2,4-D (0.9 gamma).

Left: No movement of 2,4-D and no bending.

Middle: No movement of 2,4-D and no bending when fructose was applied to upper half of leaf and 2,4-D was applied to lower half.

Right: Movement of 2,4-D and about 10 degrees of stem curvature when 2,4-D was applied to upper half of leaf and fructose to lower half. In this case sugar passed through the 2,4-D-treated area on its way out of the leaf.

the chemical method included reducing substances which were not sugars.

The amounts of 2,4-D, which were translocated from a primary leaf to other plant parts, was not correlated with respiratory rates of leaf tissue, since similar respiratory rates were observed whether conditions permitted the translocation of 2,4-D from a treated leaf or not. In addition, the amount of 2,4-D which was translocated did not correlate with the amount

of sugar which was being translocated from the 2,4-D-treated leaf. However, the regulator was translocated from a leaf only when sugar was also being translocated or when sugar was passing through a portion of the leaf where 2,4-D had been applied. Further research is in progress with respect to the previously-observed relationship between boron and sugar translocation and, in turn, the translocation of 2,4-D.

(Project K-8-c)

## DAIRY RESEARCH PROGRAM

Research projects in the Dairy Department cover phases of the production and processing of milk and its products from the birth of the calf to the use of the food by the consumer. Particular emphasis is given to the metabolism of the cow and her use of nutrients to produce milk. Metabolic diseases interfering with efficient milk production are under study. Considerable attention is given to the economical use of forages by dairy cattle.

Intensive study is underway on the chemistry of milk and its products, particularly milk fat, with reference to providing the highest quality foods. The physical characteristics of ice cream and the development of new flavoring agents for it are also under active study.

## DAIRY PRODUCTION

### **Study of the Role of Saliva in Bloat**

Saliva is known to be secreted in large amounts by ruminants and is markedly influenced by the ration. The low surface tension of saliva is thought to enhance the frothing tendency of actively fermenting rumen contents.

A study has been undertaken on the influence of saliva on rumen fermentation. This is done by ligating the salivary ducts (parotid and submaxillary)

to limit salivary flow. The first experiment has been to determine if sheep with limited salivary secretion bloat less than untreated sheep. However, thus far there has been no bloat in either group. Subsequent experiments will be conducted with these sheep to determine the influence of the lack of saliva on rumen fermentation and forestomach physiology.

(Project G-45)

## Study of Eructation in Ruminants

The eructation mechanism is essential for ruminants in order for them to eliminate the fermentation gases produced in the forestomach by their symbiotic microflora. To date this mechanism and the various factors that

influence it are imperfectly understood. With the aid of new electronic recording equipment, we have begun a study to attempt to elucidate this mechanism in more detail.

(Project G-45)

## Metabolism of Fatty Acids Investigated

Cattle produce large quantities of acetic acid in their rumen (part of stomach) which is absorbed into the blood. The absorbed acetic acid is used by the animal for many purposes. Among these are: (1) The oxidation to  $\text{CO}_2$  for energy; (2) The synthesis of longer chain fatty acids. The rate of these reactions and the manner in which the rates are speeded up or slowed down is under active study. Techniques for measurement of metabolic rate developed here have been used to determine the rate of metabo-

lism of acetic acid in steers and in lactating cows.

Growing steers use acetic acid at a rate of about 5 gms/hr/cwt, while lactating cows use acetic acid at a rate of about 3.5 gms/hr/cwt. The hormonal regulation of this metabolism is being studied by examining the effect of growth hormone from the pituitary. Growth hormone increased the rate of metabolism of acetic acid by two-thirds or more. This may explain, in part, the effect of growth hormone in increasing the efficiency of milk synthesis.

(Project G-46)

## New Information on the Bacteria of the Rumen

*Caryophanon latum*, a giant bacterium, is generally found only in cow dung. Organisms similar in appearance to this species have been invariably observed in preparations of rumen contents. On the basis of work carried out during the past year, it can be stated that there is, in fact, no connection between the two organisms. Apparently, *C. latum* grows in cow dung after it is voided, probably coming from soil or insect contamination. A number of experimental findings have verified this view, and the conclusion at present is that another organism, *Oscillospira*

*quilliermondi*, uncultivable as of now, is the true rumen inhabitant. Nevertheless, because of its immense dimensions (5 u wide X 30 u long), *C. latum* has proved a valuable organism for the study of cell physiology, and the physiological characteristics requisite for proliferation in dung. In addition, this study reiterates the oft-forgotten principle that the microscopic examination of rumen contents, in the absence of culture methods, is of only limited value in determining the ecology of microorganisms in the rumen.

(Project G-39)

## Metabolism of Radioactive Reproductive Hormone Studied

Radioactive progesterone is being used in goats to study the tissue uptake, localization and metabolism of this very important hormone. The tissue uptake is found to be influenced by the repro-

ductive state of the animal. These variations are being studied to better evaluate the role of progesterone in reproductive efficiency and in mammary gland growth. *(Project G-50)*

## Metabolic Diseases Investigated

Studies designed to find the metabolic failure in certain diseases of ruminants have been continued. The disease, ketosis, which shows some similarity to human diabetes, involves changes in glucose and fat metabolism. These changes are being studied in the large animal radioactive isotope laboratory. The information and ideas about glu-

ose and fatty acid metabolism and metabolic regulation which are developed in this study may help solve the problem of the cause of ketosis, and in understanding milk secretion. It may also be helpful in investigations of human metabolism.

*(Projects G-37; G-46; G-38)*

## Udder Edema

Bovine parturition edema has been investigated, using a total of 61 first-calf heifers. Blood serum samples taken at calving were analyzed for protein, osmotic pressure and electrical conductivity. The severity of edema was rated visually by two judges. No significant correlation was found between the blood constituents and the edema rat-

ing. The effects of no salt, restricted water, or a combination of the two were also studied as to their effect on the severity of udder edema. The results indicated a possible reduction of edema, but need further study before any conclusions can be made.

*(Project G-37)*

## Silage Used as the Sole Source of Roughage For Milk Production

Many times the greatest yield of energy per acre can be obtained from corn silage. Corn silage from fields where red clover was turned down and 200 pounds of nitrogen per acre was applied was compared with corn silage from similar fields not fertilized with nitrogen as the sole source of roughage for milking cows. All cows produced well and gained weight during the four-month period. Although the high nitrogen silage produced the toxic nitrous oxide gas during the first few days after

ensiling, it had no deleterious effects on dry matter intake, milk production, or weight gain. The addition of 4 pounds of grain to 9 pounds of protein supplement increased the milk production slightly, but not enough to pay for the additional grain. Corn silage, properly supplemented with protein, proved satisfactory as the sole source of roughage.

In further work to find out what factors sometimes decrease the dry matter consumption of hay crop silages, a feeding trial which compared alfalfa hay,

alfalfa hay plus ammonium lactate, and alfalfa silage was conducted. All groups produced nearly the same amount of milk; but the silage group ate less dry matter than the other two groups, and

the group fed ammonium lactate gained the least weight. The ammonium lactate at the level fed did not depress the dry-matter intake.

(Project G-52)

## Nitrogen Fertilization of Orchardgrass For Pasture

The 1960 grazing season was the first complete year for this cooperative study with the Agronomy Department. The carrying capacity (animals per acre) was higher for the orchardgrass pastures treated with 200 or 300 pounds of nitrogen per acre than for the orchardgrass-ladino control treatment or the 100-pound level of nitrogen treatment. Milk production per cow was highest

for the orchardgrass-ladino control. The fifth treatment of sod-seeded cereal rye and Bermudagrass gave peak carrying capacities in April and again in July and August. However, milk production per cow fell off markedly during the periods of rapid growth during July and August. This study will be continued for two more grazing seasons.

(Project BG-1)

## Nutritive Evaluation of Forages

A comparison of the digestibility of early and late varieties of forages was made by feeding hays harvested on two dates to steers. Williamsburg and Du-puit alfalfa and Potomac and S-37 orchardgrass were selected because they represented fairly wide ranges in the length of time needed to reach matur-

ity. Preliminary results indicate that the digestibility of the later S-37 orchardgrass harvested on the same date is 5 to 6 percent higher than Potomac orchardgrass; however, there appears to be little difference in the digestibility of the two varieties of alfalfa.

(Project G-47)

## Pelleted Hay For Dairy Heifers

In a cooperative study with the Dairy Cattle Branch of the U. S. Department of Agriculture, 24 heifers were used in a growth study to test the effect of stage of maturity and pelleting on the nutritive value of hay. An early- and a late-cutting alfalfa and a late-cutting orchardgrass hay, cut on the same date as the late alfalfa, were fed in both the long and the pelleted form. The forages were fed *ad libitum* with no concentrates.

The pelleted forages were consumed in significantly larger amounts and produced significantly greater body-weight gains. The greatest improvement by pelleting was with the poorer quality

forages. The average daily body-weight gain and average daily pounds of hay consumption were as follows: Long early cut alfalfa, 1.29 and 14.3; pelleted early cut alfalfa, 1.66 and 15.0; long late cut alfalfa, 0.80 and 10.6; pelleted late cut alfalfa, 1.41 and 15.2; long late cut orchardgrass, 0.28 and 10.2; pelleted late cut orchardgrass, 1.29 and 13.5.

The U. S. Department of Agriculture is using the hays in net-energy determination studies, and feed values will be available for comparison of the growth with digestible energy, metabolizable energy, and net-energy feed values.

(Projects G-47; 51)

## DAIRY TECHNOLOGY

### New Class of Fatty Acids Discovered in Butterfat

Study of the naturally occurring carbonyl compounds in fresh butterfat has revealed the presence of 0.2 to 0.4 percent keto-acids esterified in the triglyceride structure. The acids range in chain length from 16 to 18 carbons. Study is currently under way to locate

the position of the ketone group in the fatty acid chains. Preliminary examination of other animal and vegetable fats has indicated that all natural fats contain small quantities of keto-acids.

(Project G-48)

### Carbonyl Compounds Formed in Milk on Exposure to Sunlight

Milk is exposed to various intensities of light energy during processing, distribution, and consumption. Exposure to light is well known to produce off-flavors in the milk. Study of the chemical mechanism of this flavor development during the past year at Maryland has indicated that the problem is basically one of autoxidation of the lipids in the milk. A class of compounds

known as B-unsaturated aldehydes has been identified as formed in milk by light-induced oxidation of unsaturated fatty acids. These compounds, ranging in chain length from 6 to 11 carbons, are potent oxidized-flavor compounds when present in milk at concentrations than one part per billion.

(Project G-35)

### Technology of Utilizing Concentrated Fruit Juices and Essences in Ice Cream and Related Products

Investigations have been completed relative to the development of formulas for using fruit concentrates and essences in fruit ice cream, sherbets, ices, ice milk and variegated ice cream. The amount of flavoring material, sugar content of the mix, and acidity control have proved to be important factors in producing the desired flavor.

Fruit concentrates and essences have

proved to be a valuable and economical means of improving the flavor of some varieties of fruit ice cream and related products.

Fruit concentrates and essences are available commercially, and their use in ice cream manufacture provides a significant outlet for fruits processed in this form.

(Project G-42)

### Study Causes of Variations in Cottage Cheese

Variations in the characteristics of cottage cheese, as a result of several treatments, were investigated. Previous history of the milk-acidity and pH measurements, rate of heating, temperature of cooking, length of cooking,

speed of cooling and degree of cooling were studied. No single measurement or technique effectively established a sound basis for the development of a standardized manufacturing procedure.

The studies indicated that the suc-

cess or failure of a batch of cottage cheese is dependent, to a large degree, upon the characteristics of the curd at cutting. The condition or rigidity and the type of curd at cutting is controlled by the previous heat treatment of the milk and the activity of the starter and

the coagulator. Preliminary studies, in which curd rigidity or strength was used as the criteria for establishing the correct cutting time, look promising. Several methods for determining curd rigidity have been used and all give similar results. (Project G-53)

### **Study Effect of Heat Treatment on Cottage Cheese Production**

Milks pasteurized at 143° F. for 30 minutes or 160° F. for 15 seconds possess excellent properties for the manufacture of cottage cheese. In recent years, milk processing lines incorporated various deodorizers into the operation in order to remove undesirable flavors and odors from the market milk supply. These units have improved the flavor of many milks. However, the milks so treated have been subject to increased levels of heat treatment, which results in increased water-binding property of the milk proteins.

Milks properly pasteurized and processed in a direct steam-injection type deodorizer were studied. The added heat treatment made it difficult, and in many cases, impossible to expel sufficient whey from the cheese curd to produce the dry, meaty curd of a high-quality cottage cheese. The resultant cheeses, because of the high moisture content, could not be properly drained or creamed, and after 24 hours of commercial storage, excessive whey-off developed. In all cases, short shelf life was encountered. (Project G-40)

### **Measurement of Oxidized Flavor in Milk**

A method has been developed for measuring oxidized flavor in milk that not only correlates with organoleptic evaluation but measures changes at or below threshold values of flavor recognized by the judges. This method is based on the color reaction of 2-thiobarbituric acid and is considered much simpler to carry out and more reproducible than other methods based on this and other reactions. The improved method is the result of a careful study of reaction conditions car-

ried out in a continuing study of the basic mechanism for oxidized-flavor development in milk. Studies of reaction kinetics, as influenced by various factors are under way.

The color-reaction method should be readily applicable to routine plant-quality control where oxidized flavor is a problem. The length of time a susceptible raw milk supply can be held before processing could readily be determined without the necessity of cumbersome flavor panels. (Project G-34)

## ENTOMOLOGY

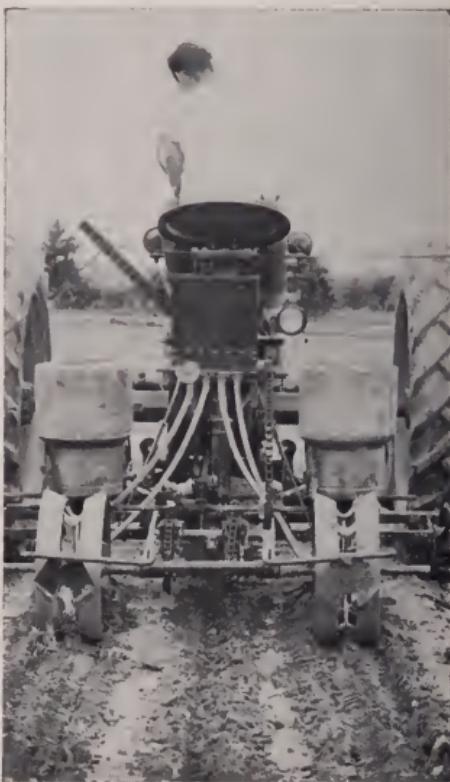
Current agricultural production methods are extremely complex and call for the investment of large sums of money. Producers cannot afford to risk losses caused by insects. Department of Entomology research workers help farmers prevent losses from insect damage, and they are ever mindful of the practical problems involved. At the same time they are seeking the answers to many fundamental questions in the areas of morphology, physiology, toxicology, taxonomy, and ecology.

### Chemical Control of Insect Pests of Sweet Corn

For some years, DDT has been the most widely recommended insecticide for control of corn earworm. DDT does not control the dusky sap beetle which attacks the ear of corn, and DDT-treated fodder cannot be fed to animals. For the past several years the Department of Entomology has conducted a screening program for materials that will kill both insects and will not leave harmful residues on corn fodder. One insecticide, Sevin, does not have these disadvantages.

Recent work conducted on corn-insect control indicated that systemic insecticides applied with the seed at planting time have certain beneficial effects. Corn so treated has shown increased stands and more vigorous growth because of control of insects in the soil. Flea beetle injury and the disease, bacterial wilt, that is carried by the flea beetle is reduced. There is evidence that this type of insecticide treatment is also effective against the European corn borer.

Last year, several experiments were conducted for control of European corn borer. Not only were chemicals assayed for their effectiveness but also factors



Planting seed corn with systemic, granulated insecticides applied to the soil with the seed.

such as time of application and method of application were investigated. The results of these experiments were helpful in that they indicated not only which insecticides were of possible

value but also that the method of application and time of application is an important factor in European corn borer control. More work along this line is planned. *(Project H-29-n)*

## **Pea Aphid Control to be Changed in 1962**

Following results of small plot experiments carried out during the seasons of 1959 and 1960 on the control of pea aphid with new and promising insecticides, extensive commercial treatments of peas were made with dimethoate and phosphamidon during the spring of 1961. These two insecticides were applied at the rate of 2 and 4 ounces per acre with both ground and air equipment and found to be highly effective. These insecticides are organic phosphorous chemicals with definite systemic action, and it is believed that they will be consistently more effective than malathion when applied by airplane. Since they are systemic, it is believed they will perform well with the less complete coverage characteristic of aerial application.

Phosphamidon has been approved for use on peas with a time limitation of 16 days before harvest and is being recommended for airplane application only.

Malathion, because of its comparative safety to spray operators and short

time limitation, is still recommended for use in ground sprayers and for air application where treatment must be applied within 16 days of harvest. Either malathion by ground sprayer or phosphamidon by airplane should give complete kill of aphid on peas within 4 days after application.

Dimethoate is highly effective against the pea aphid and has provided a longer period of protection before increases in aphid populations occur. It is comparatively a very safe insecticide to apply because of its low mammalian toxicity. As yet it has not been approved for use on peas, but if and when it is, it will be highly recommended for pea aphid control.

The recommendation for use of phosphamidon for airplane spraying of peas in 1962 is the first change made for control of the pea aphid since 1953. During the 9-year period that malathion has been used for spraying peas in Maryland, pea production has been the highest ever attained in the state.

*(Project H-46-e)*

## **Commercial Control of Cabbage Looper by Polyhedrosis Virus**

The Maryland Agricultural Experiment Station in cooperation with the Eastern Shore Branch of the Virginia Truck Experiment Station has found in extensive commercial applications that the polyhedrosis virus of the cabbage looper is extremely effective in protecting crops from damage by this insect. In these preliminary commercial-scale experiments the virus treat-

ment has been more effective under field conditions than any known insecticide. Since the cabbage looper is the most difficult of the cole crop pests to control, it appears at this time that by including the virus in the pesticide program chemical control can be greatly simplified, with considerable reduction in cost of keeping crops free of insects. At College Park results indicate that a

treatment schedule of polyhedrosis virus and malathion will completely protect broccoli from insect damage without leaving insecticide residue on the heads at harvest time.

The work on this problem will be intensified in the immediate future with three main objectives: (1) To develop a reasonably dependable method of mass rearing of cabbage looper larvae. The virus is highly specific, affecting only the cabbage looper and, like all viruses, reproduces only in living tissue, in this case the cells of the cabbage looper. (2) To standardize and formulate the virus in a suitable medium for distribution to growers. (3) To obtain

such toxicological information as is needed for clearance and approval of the virus for sale and use.

Work on the first objective has been carried on at the Maryland Station for the past 2 years, and although it is felt that considerable progress has been made in simplification of mass rearing methods, we have not been able to carry consistently large numbers of larvae through their development from egg to pupa. Larval populations have become repeatedly infected with the virus and lost before the desired growth is obtained. It is hoped that these difficulties can be overcome satisfactorily in the near future. *(Project H-46-e)*

### **Control of the Codling Moth**

During 1960 and 1961 a project was set up to test dust formulations against codling moth and other fruit pests. The equipment used in these experiments was a John Bean Niagara Model 110 "Cyclone" orchard duster. In 1961, the duster was modified to apply both charged and uncharged dusts. A new nozzle arrangement, with an electrode in the center of each nozzle and a high-voltage unit were manufactured by the Miller Chemical and Fertilizer Corporation, Baltimore, Maryland. The high-voltage unit produced 13,000 to 15,000 volts to each electrode.

Twelve large plots were used for testing the machine and various combinations of dusts. Six plots were used for making the applications in the regular manner, and the other six used for testing the materials with the charged particles. Records taken at the end of the season showed there was no significant difference in the control with the charged and uncharged dusts. Some of the combinations gave good control of codling moth and plum curculio and

fair control of the red-banded leaf roller. All of the combinations gave good control of the rosy apple aphid. The control of diseases, however, was not satisfactory in these tests.

The experiments using dusts against peach pests and pests of non-bearing apple trees proved to be highly successful, and at least four commercial growers are using dusts in a complete program for the control of peach pests. This is much more economical than the spray program usually followed. A dust machine will cost approximately \$1,000, as compared to \$7,000 for a spray machine. Depreciation and operating costs for dusting are substantially lower than for spraying.

A large number of new insecticides are tested each year in spray programs. It has been apparent for several years that codling moth had become resistant to DDT. As the result of this apparent resistance very little DDT has been used in Maryland orchards during the past 5 years. Assuming that after elapse of 5 years, the moth resistance would

be broken, we are now recommending DDT again. However, during the past 5 years new insecticides, such as Guthion, Sevin, Phosphamidon and Dime-thoate have been tested and proved ef-

fective in many cases. Guthion and Sevin are outstanding in the control of codling moth and are being used in a complete program by many commercial growers. (Project H-48)

## **Identification and Control of Mites Causing Damage to Apple Orchards**

Orchard mites are considered one of the major pests of apples. They are capable of building up resistance to an effective acaricide within a period of 3 years. It is, therefore, essential to test new materials to replace those no longer effective. During 1960 and 1961 various combinations of acaracides were tested in the prebloom and midsummer applications. The most effective prebloom treatment was a combination of oil emulsion and liquid parathion applied in the delayed dormant period and followed by Mitox in the pink application. In many instances this treatment gave good control of mites throughout the season. The mid-summer acaricide treatments consisted of Tedion + TEPP, Kelthane + Tedion, TEPP + Kelthane, and Kelthane alone. Of all these combinations, the Tedion + TEPP gave the quickest reduction in the mite population. However, after a period of approximately 4 days there

was very little difference in any of the treatments. In this particular series of tests all of these miticides gave good control, ranging from 99 to 100 percent at the end of 19 days. However, during this same period the population on the check plot decreased 86 percent.

The results with the prebloom treatments for mite control were so outstanding that practically all commercial growers in the state have adopted this method of treatment in their 1962 spray program. It has proved to be the most economical from the standpoint of materials and it prevents the bronzing of foliage that results when summer treatments are used. Orchards that are bronzed as the result of heavy mite populations will produce a crop of small-sized fruit with very poor finish. The prebloom sprays have been effective in alleviating this condition.

(Project H-69)

## **Two Granular Systemic Insecticides Show Promise on Potatoes, Lima Beans**

In extensive experiments with several granular organic systemic insecticides applied in bands with seed at planting time or as a side dressing to newly set or emerging plants, Thimet and Di Syston show promise on potatoes and lima beans. In the experiments of 1961, both of these insecticides controlled Colorado potato beetle, Mexican bean beetle, flea beetles, potato leafhopper and aphids for periods up to 60 days, and their use resulted in significant increase in yields of these crops.

They were not, however, effective in killing chewing insects on eggplant, tomato, cucumber, cantaloupe, and cabbage.

Cynem, an insecticide-nematicide, has given encouraging results for use on strawberries. In the first year's results of a three-year experiment, plots treated with this chemical produced approximately 25 percent more fruit than plots treated with dieldrin or plots receiving no treatment.

Systemic insecticides will not be rec-

comended for use in Maryland until more experimental results are obtained, though present information indicates that Thimet may have a place for use on lima beans.

Many new systemic insecticides are

appearing, and extensive work with these materials is planned for the future. They will be observed both as foliage sprays and in soil application.

(Project H-46-e)

### **Alfalfa Weevil Controlled with Fall Applications of Insecticides**

Experiments have been conducted on the control of alfalfa weevil with insecticides applied after the last cutting. The applications of heptachlor or dieldrin at the rate of 1 pound per acre gave excellent control of the weevil when applied in mid-November. Earlier treatments were less effective. Applications were made with granular carriers and as sprays, with both giving excellent results.

Heptachlor and heptachlor epoxide residues on hay with this treatment

were zero when the treatment date was no later than November 15. Dieldrin residues were also zero on the green-cut hay, but hay dried artificially or field-cured yielded low levels of residual dieldrin.

Experiments on spring treatment of alfalfa for the weevil have as yet not demonstrated any materials superior to the current recommendation of me-thoxychlor and malathion.

(Project H-71)

### **Physiology of Insect Reproduction**

Knowing more about how mosquitoes reproduce is essential before these insects can be efficiently controlled either by the sterile-male technique or through the use of sterilizing chemicals. The problem is especially complicated because nearly all of the activities associated with mosquito reproduction are very rapid. A single male *Aedes* mosquito is capable of inseminating about 5 females in rapid succession (over a 5-minute period) but will copulate with as many as 10 more females. A single male mosquito can be "depleted" of sperm and accessory gland material when placed with a great excess of

females (20 females to 1 male), and he will remain "depleted" for about 2 days, after which time he is capable of completely regenerating sperm and accessory gland material. If the male is never depleted of sperm, then the number of available sperm slowly diminishes with time, but if he is depleted he forms a great excess of new sperm. In nature, male mosquitoes probably never become depleted of sperm. Sterile male mosquitoes are sometimes encountered in the laboratory colony and these have very small testes totally devoid of sperm cells but in all other respects they appear normal.

(Project H-72)

### **Biology and Control of Tobacco Insects**

The green-peach aphid is a pest of primary importance to Maryland tobacco. Aphids usually attack tobacco late in the season when the plants are large

and coverage is difficult. Because of this, aphids on tobacco are often not controlled. For the past 3 years, most of the research on tobacco insect con-

trol has been directed toward finding control measures that do not have the disadvantages of foliar sprays applied to large tobacco plants. Granulated, systemic insecticides applied to the soil before planting or side-dressed when the plants are small have shown promise as a good means of aphid control. The

inclusion of systemic insecticides in transplant water has also shown that this may also give control of green peach aphid even until the plants are harvested. A practical, effective technique for controlling green peach aphid could evolve from these experiments.

(Project H-74)



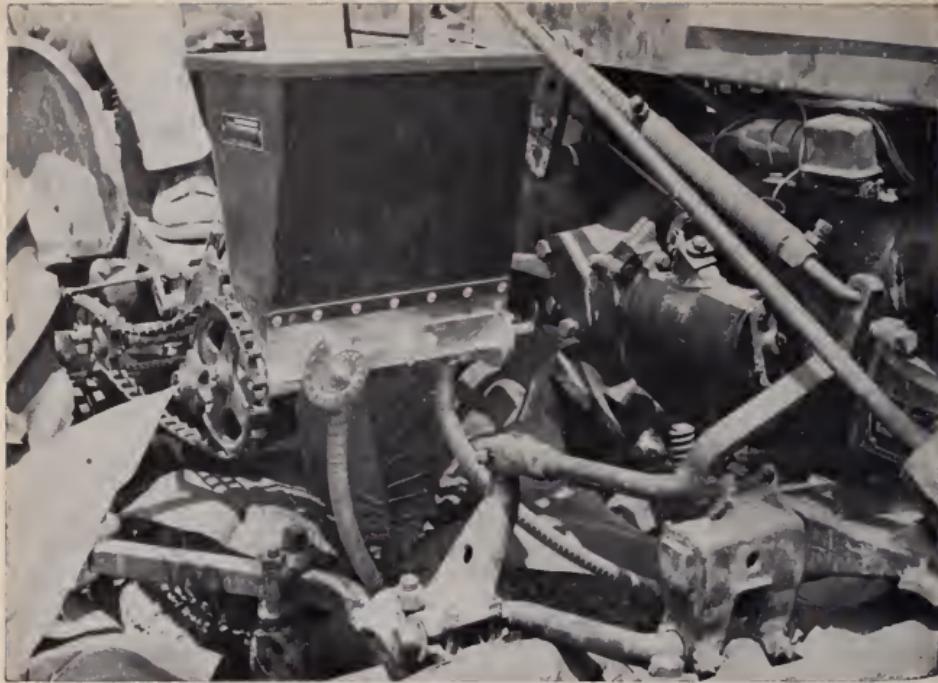
Machines such as this one developed at the University of Maryland are used in evaluating insect control methods.

### **Comparative Morphology and Physiology of Insect Blood Cells**

Cockroaches are very "tough" insects and hard to kill. Their blood coagulates very rapidly when they are wounded and they lose very little blood. Certain blood cells are specifically responsible for coagulation of the blood. We have been studying the "coagulation" cells in relation to the molting cycle. There is a close correlation between the amount of blood in the cockroach and

the number of blood cells which are circulating. When the cockroach crawls out of its old skin (ecdysis), it is swollen and its blood volume is higher than at any other time. The number of blood cells is reduced just at this time, but the number of "coagulation" cells is highest and the cockroach's blood is more coagulable right after the ecdysis.

(Project H-76)



Close-up of a device attached to a small tractor used for side dressing small amounts of granulated insecticide to tobacco.

Studying coagulation of the blood of cockroach.



## The Susceptibility of the Red-banded Leaf Roller, *Argyrotaenia Velutinana* (Walker), to TDE

To determine the susceptibility of the red-banded leaf roller to TDE, it was first necessary to find a method for rearing the insect through several generations. Of the methods attempted, the following two proved to be the most satisfactory.

Three strains of leaf roller were obtained in the egg stage. As larvae hatched from these eggs, they were placed on Scarlet Runner bean plants in cages in a plastic-covered greenhouse. The insects were allowed to develop through the pupal stage undisturbed. Moths emerging in the cages were removed and placed in battery jars lined with waxed paper. Each jar contained a piece of gauze moistened with a 5 percent sugar solution as food for the moths. The insects mated and the females deposited their egg masses on the waxed paper. The lining was removed from the jars after 7 days and small pieces of the paper, each containing an egg mass, were cut out and were placed on paper toweling in petri dishes. The egg masses were checked daily for hatching, and the emerging larvae were transferred to cages in the greenhouse. The cycle was then repeated.

The second method employed the same procedure for securing egg masses, however, these larvae were reared on Scarlet Runner Bean leaves in battery jars in the laboratory. The upper edge of the jar was coated with petroleum jelly to prevent the larvae from escaping. These jars were covered with a piece of muslin and a glass plate. Moths emerging in the jars were removed and placed in lined battery jars.

Several facts were determined during the rearing experiments. Although both

methods were satisfactory, the method using the bean plant rather than the bean leaves gave the largest number of individuals completing a cycle. High humidity was necessary in the petri dishes to insure the hatching of the largest number of eggs, therefore, the paper toweling was kept moist at all times. The problem with diapause during the first winter was eliminated by the use of artificial lighting in both the greenhouse and in the laboratory.

The moths showed a tendency to be negatively geotropic in their actions. They were usually found near the top of the cage or jar. The larvae also showed this tendency. The larvae were extremely sensitive to touch and would spin a web as they dropped from the top of the cage or jar to the bottom.

(Project H-77)



Laboratory rearing of red-banded leaf roller.

## Amino Acid Metabolism in Insects

Continuing studies on the metabolism of amino acids and proteins in insects in relation to the toxicology of insecticides have brought forth some interesting data. It was previously reported that blood alanine of *Drosophila* larvae decreased with diets high in nitrogen, and that the resultant flies were more susceptible to DDT. Studies of alanine metabolism in the American cockroach indicate that it may be a natural pre-

cursor to phenylalanine and tyrosine, which are in turn the precursors of the quinones and melanins of insect cuticle. These results hint that DDT susceptibility may be altered in part by the presence or absence of sufficient quantities of alanine for complete hardening and darkening of the cuticle. Further work will be necessary before any conclusion may be drawn.

(Project H-78)

## Classification of Green Lacewings

Green lacewings (Neuroptera: Chrysopidae) are beneficial insects. The larvae, known as aphis-lions devour large numbers of aphids and other small pests. They are very abundant in alfalfa, clover and pea fields and are frequently encountered in orchards and gardens, wherever aphids are present. Basic studies have been underway for several years to clarify the taxonomic

status of several species known from Maryland and other states.

The male terminalia furnish clues to the identity of those species which have been thoroughly investigated. Ten species have been studied and pertinent structures have been described and figured. This work will facilitate accurate determinations of these insects.

(Project H-79)

## HOME ECONOMICS

The variable quantity and kind of protein eaten daily has been an indicator of health throughout the world. Since protein is not stored in the body like carbohydrate and fat, nitrogen balance (the difference between nitrogen intake and nitrogen output) has been used as a criterion of protein adequacy. Normally, nitrogen is excreted as a result of body metabolism. If extra protein is eaten, more nitrogen is excreted; or if little protein is eaten, the quantity of excreted nitrogen from normal metabolic processes may be of sufficiently quantity to cause negative nitrogen balance.

## Relationship of Low-Protein Diet to Body Weight and Composition

It is generally assumed that when a person has the same body weight each day there is little change in body composition. It is further assumed that the

food intake is adequate, the use of nutrients, the building and breakdown of body tissue is normal.

When the daily dietary protein is

insufficient, there is a loss of body weight. This is accompanied by a lack of balance between nitrogen intake and output (excretion). The body is in negative nitrogen balance, excreting more nitrogen than is eaten showing the use of nitrogen from body tissues. During five of the six metabolic experiments conducted by this laboratory with college women eating low protein diets each subject was given sufficient Calories to maintain body weight. The "adjustor" Calorie foods contained mainly carbohydrate and fat without protein and other nutrients. As each experiment progressed there was an increasing need for "adjustor" Calories, averaging 700 to 2000 Calories for the different experimental groups. This was unusual and somewhat unexplainable.

To evaluate the body weight data of 70 normal college women in 6 metabolic experiments the following were studied: The standard weight for height and age ("Personal Health Standard and Scale" by Thomas Wood), actual height, surface area, initial body weight, daily fluctuation in body weight, final weight, difference between initial and final weight, additive gain in weight, additive loss in weight, and average body weight. Most researchers think of constant body weight as being a weight fluctuation of less than 2 to 3 pounds per month, 6 weeks, or 12 weeks of experimental time.

The age of the subjects ranged from 18 to 24 years. The average age was 19.7 years.

It is important in such experiments that the chosen subjects are within 10 percent of normal or standard body weight. Two or three subjects in each experiment had body weights outside the 10 percent limit. The reaction of these subjects in respect to nitrogen balance, Calorie utilization, protein and fat availability, and body weight fluc-

tuation was similar to that of subjects whose body weight was within the 10 percent limit of standard body weight.

In Experiment I the average change in weight for the 9 subjects was 4.8 pounds. This included the weight changes of two individuals who lost between 10 and 12 pounds of weight because of excessive workload. The body weight of the other subjects was quite constant.

In Experiments II, III, and IV the change in body weight for the experimental period was similar. In Experiment II, with 11 subjects, it ranged from -4.5 to +2.5 and averaged -2.3 pounds. In Experiment III, with 9 subjects, it ranged from -4.5 to +3.0 and averaged -0.7 pounds. In Experiment IV, with 18 subjects eating 3 slightly different diets, it ranged from -1.3 to +3.3 and averaged +0.8 pounds.

In Experiment V the slight differences in Caloric needs of the subjects were not taken into account. The iso-caloric diet contained approximately 2850 Calories which was close to the average Calories required for body weight maintenance by the individuals in previous experiments. The change in body weight of the 12 subjects ranged from -1.0 to +7.5 and averaged +3.7 pounds.

In Experiment VI the average change in body weight of the 11 subjects for whom "adjustor" Calorie foods were used was -2.3 to +4.5 pounds. The average weight change was +1.2 pounds.

The daily body weight records of each of the 70 subjects showed considerable fluctuation from day to day and week to week. Most of the subjects changed  $\frac{1}{4}$ ,  $\frac{1}{2}$ ,  $\frac{3}{4}$  or 1 pound of weight from day to day. For example, one student gradually increased in weight from 110 pounds to 115 pounds, then decreased to 109 pounds, so that

the difference between the initial and final weight was only -1 pound. The body weight of 10 subjects fluctuated very little.

Ten subjects showed no difference between initial and final weight but the fluctuation in weight from day to day was the same as for other subjects. Twenty-nine of the 70 subjects showed a difference between initial and final weight of 2 pounds or less. Fifty of the 70 subjects showed an average weight within 2 pounds of their initial weight.

In order to study this more exactly, all of the daily gains in weight and all of the losses in weight for a given subject were totaled for the entire 6 week period. This exaggerated the range of body weight for each subject. For example, the same subject cited above having a difference between initial and final weight of -1 pound had gained altogether 16.5 and lost 17.5 pounds. If taken literally, this could mean that body composition changed considerably during the experimental period. The change may have been in fat, carbohydrate or water content. Two other subjects who lost the largest amounts of total weight and gained the most total weight were subjects who showed a difference of only 1 pound between their initial and final weight. At the same time, one subject who had lost only 0.5 pounds during the 6 weeks had a total loss and gain less than any other subject. Therefore, irrespective of the initial and final body weight, subjects on the same diet may have a small or large total loss and gain in body weight.

Each of the 6 experiments were conducted during October and November. Generally students become more active as the fall semester progresses so this may partially account for the increased Caloric need of the subjects.

The Calories of the diets were low and perhaps insufficient at the beginning of the earlier experiments, and yet some subjects of smaller surface area gained weight. The increased need for Calories may have been caused by the stress of extremely low protein intakes at the beginning of Experiments II, III, IV. However, in Experiment VI, when all subjects had a minimum but adequate amount of dietary protein with 2500 Calories, similar or slightly greater fluctuations in body weight occurred with little need for additional Calories. The data indicate that no changes in body weight could be directly related to dietary changes of protein or fat.

The daily water intake may have varied. The subjects obtained the distilled water for drinking from the laboratory supply and most subjects seemed to use similar amounts day after day.

Since these 70 subjects ate relatively similar diets, we can say that body weight was successfully controlled by "adjustor" calories, although body composition may have changed to some degree. The isocaloric diet of 2850 Calories controlled body weight of college women to a lesser degree. A need for studies relating to change in body composition and the usual daily body weight fluctuation of individuals is indicated.

## HORTICULTURE

The efforts of Horticultural research are aimed at more efficient production of better fruits, vegetables, flowers, and ornamental plants, with the common goal of higher returns for the producer and better products for the consumer. The research program thus involves studies ranging from plant breeding to the canning and freezing of fruits and vegetables, carried on in the laboratories and greenhouses at the University, on the experimental farms, and on the farms and orchards of cooperating growers throughout the state.

Some of the recent results of the research program are briefly presented in the following pages. More detailed information is available in scientific journal papers, station bulletins, and popular articles released by the Experimental Station.

### **Spray-Thinning of Apples Breaks Biennial Bearing**

York apple trees in a moderately vigorous orchard in Western Maryland have been spray-thinned for 6 consecutive years with naphthalene acetamide, the chemical now recommended by the Maryland Station for this important variety. Outstanding results over the 6-year period were increased fruit size and more annual bearing. In the first "off" year, 1955, unsprayed trees yielded an average of 2 bushels per tree, while spray-thinned trees produced 5 bushels; in the second "off" year, 1957, these figures were 1 and 12 bushels respectively. Fruit size in the heavy (or

"on") bearing years was substantially increased by spray-thinning throughout this study. Overall yield on these trees was neither increased nor decreased by spray-thinning procedures.

The results establish that spray-thinning has consistent and practical advantages for the Maryland apple grower. Production from year to year can be made more uniform with this technique, and it offers an inexpensive means of increasing fruit size which is of importance in both fresh fruit and processing outlets.

*(Project L-74-b)*

### **York Spot Controlled but Not Eliminated**

Apple trees of three important varieties have been fertilized annually with heavy applications of potassium for the past eight seasons. The trees are growing in Braddock gravelly loam in Frederick County, are relatively low in potassium content in wood, bark, and leaves, but have been very productive of fruit through the course of this study.

A detailed study of the Red Delicious trees was made in the sixth and seventh year of this experiment. Annual applications of  $2\frac{1}{2}$  and of 10 pounds of muriate of potash per tree up to this time failed to increase fruit size or yield significantly, though there was some evidence that potassium did increase yield. Fruit potassium was increased as was exchangeable potassium in the soil.

However, no change was found in the potassium levels in bark and wood of limbs, trunk, or roots.

The results indicate that even though leaf analysis may show potassium levels to be relatively low, heavy potassium

fertilization over a period of years is not likely to increase potassium substantially in the various tissues of the plant, and may not provide a return on the investment in the form of larger fruits or higher yields. (*Project L-79-d*)

## Experiments with boron in Treatment of York Spot

Investigations by the Maryland Station in 1957 and 1958 indicated that early-season sprays of boron would significantly reduce the incidence of York Spot in Maryland orchards. Extensive experiments since that time have confirmed this effect, and have indicated that boron sprays can be depended upon to reduce the incidence of York Spot to a basic "threshold value" of about 25 percent, but no further.

Evidence at hand indicates that three sprays of boron, commenced during blossoming or shortly thereafter, and applied at about weekly intervals, will be most effective in reducing York Spot. Sprays applied at these times substantially increase the boron levels in leaves and fruits, while sprays applied later in the season increase boron

levels only in the fruits. However, the later sprays have little influence on York Spot.

Dramatically improved color and finish of the fruit were produced by early boron sprays in the very dry season of 1957. These effects have not been repeated in seasons of more normal rainfall which have followed. Some Maryland orchardists continue to achieve improved fruit color and finish with boron sprays, however; so the practice is being widely used in the state for this purpose alone, if not for reducing York Spot.

Work on this project is being continued largely with calcium salts applied with and without early boron sprays to eliminate the disorder.

(*Project L-74-c*)

## Blanching and Short Storages May Reduce Sloughing in Processed Green Beans

A 2-year study of sloughing, an important appearance factor of canned green beans, has shown it to be the result of groups of intact epidermal cells becoming separated from the hypodermal cells comprising the bean pericarp. The consumer is very critical of green beans that show these symptoms and will not repurchase a brand consistently high in sloughed beans.

Sloughing is basically a problem of cellular adhesion, and the most important factors controlling sloughing of green beans are the quality and quantity of the pectic cementing materials

binding the walls of adjacent cells together. Therefore, any factor found to increase sloughing must have some physical or chemical effect on this intercellular cement, causing it to be weakened or destroyed.

Sloughing was found to be more prevalent in beans grown in hot, dry weather, in the larger more mature beans, and in beans receiving extended periods of storage. The blanch time and temperature were important factors. "Sloughing was reduced by increasing the time of blanch at temperatures below 180° F, but was increased at tem-

peratures above 180°. Samples in which blanching has been omitted altogether sloughed rather severely. Varieties studied sloughed in ascending order as listed: C-12-6 (a flat bean), Pearlgreen,

White Seeded Tendergreen, Corneli 14, Harvester, Tenderwhite, and Tendercrop. After processing rough handling greatly increased the incidence of sloughing. (Project Q-58-n)

## What Makes an Apple Soften

In a study of the cell-wall constituents of the apple fruit, several polysaccharides which may have a profound influence on softening or changes of texture during cold storage or thermal processing have been found. The hydrolytic products of these cell walls, after treatment by a commercial pectic enzyme, show the presence of glucose, galactose, mannose, xylose, arabinose, as well as galacturonic acid and possibly glucuronic acid. Several 4-carbon sugars and lactones are also found mixed with these substances. Because of the great array of these hydrolytic

products it is difficult to ascertain which substance or group of substances has the greatest influence on apple softening.

It does appear, however, that the greater the amount of admixed materials with these "pectic" fractions the firmer the apple. A starchy-polyglucose which resists amylase action and stains blue with iodine appears to be the key substance in this complex. This complex must be broken down or converted into simpler compounds before softening in the apple can take place.

(Project Q-58)

## Some Factors Affecting Hydrangea Flowers

In the course of several studies, it has been found that a full complement of leaves is necessary on the hydrangea in the fall months for flower initiation. Flower initiation is inhibited when the leaves are removed and smaller inflorescences develop with fewer leaves present. This is important to the producer, since it is essential that many leaves remain on the plant in the fall months for flower initiation before the winter dormant period.

A 10-hour photoperiod in the several weeks previous to winter storage resulted in more branches with flower buds than were produced on plants growing under long-day conditions of

18 hours. This suggests to growers that they be careful to shield or screen hydrangeas from any additional light that they may be giving to other crops.

Plants stored at a 46° F. temperature, and compared to 36° F., had more stems which produced flower buds and with larger inflorescences. Plants stored in a coldframe gave results similar to plants stored at the 46° F. temperature. There appears to be a relationship of storage temperature to the retention of leaves. At the warmer temperature, leaves remain on longer, and this may account for the difference in the number of buds initiated.

(Project I-74-a)

## Fertilizer Ratios for Greenhouse Cut Flower Crops

On the basis of 9-year studies under greenhouse conditions, a fertilizer ratio

of 3-1-1 adequately meets the needs of roses and snapdragons. For chrysanth-

mums and carnations, a ratio of 3-1-1 gave better production and quality of flowers. In the course of these studies, plots were established to which a uniform rate of nitrogen was given, while the phosphorus and potassium ratios were varied. During the period of study

several different crops were grown. Ground limestone was added to maintain the necessary acidity of the soil, and peat moss was added to maintain a good soil structure.

(Project I-74-B)

### Germinating Cyclamen Seed

Propagators of cyclamen will find it practical to keep germinating seed at a moderate temperature for most rapid germination. Studies have shown that germination of seed is most rapid if it is kept at 65° F. for 32 days or if the first 16 days are cooler, at 50° F., but followed by the warmer 65° F. period for 16 more days. In this study, the seeds were kept on moist blotting paper

in petri dishes under controlled conditions, then planted in a soil-peat mixture and placed in a greenhouse at a 60° F. night temperature. Temperatures of 50° and 80° F. during the germination period delayed germination as much as 6 weeks, as compared to results with 65° F.

(Project I-74-A)

### Vegetable Variety Investigations

A continuous and exhaustive study of new and improved varieties of vegetable crops is maintained to provide detailed information on variety capabilities. All characteristics pertinent to growing, harvesting, raw-product preparation, and processing are evaluated objectively.

The snap bean study was expanded to include two new types (Bush Romano and Bush Blue Lake) much desired for canning and freezing by Maryland processors. Bush Romano types are still in the developmental stage, and the information obtained was designed to assist the plant breeders in their efforts. The bush type Blue Lake was considered to be acceptable in the field and superior to conventional bush beans after processing. This commercial bean development will be named and released within a year.

A part of the study of carrot breeding lines and varieties (Cooperative



A new green-seeded Fordhook line showing pod set at 4 days before prime harvest.

with USDA) includes screening lines for *alternaria* resistance. A slight degree of resistance has been found.

A number of green-seeded Fordhook breeding lines reportedly with heat resistance were tested. Four were selected

for further study in the coming year. High yield potential, heat, and to some extent, drought resistance, were demonstrated by the four select lines.

(State Project Q-74)



Alternaria screening block for carrots. Foreground: Right row complete loss, left row some foliar regrowth after initial attack of disease.

## POULTRY

In a recent issue of an outstanding newspaper in the United States, the following statement occurred: "The United States, with probably the most efficient poultry breeding industry in the world, is selling frozen chickens to West Germany at the rate of 30 million dollars worth a year." This serves to document the efficiency with which agriculture of the United States operates; and, of course, is particularly flattering to the poultry industry. The practices that have made this efficient production possible have been at least partly the result of intense research programs in the poultry field to improve methods of breeding, feeding, disease prevention, and management in general.

The research laboratories at the University of Maryland have, at least in a small way, contributed to the total sum of poultry knowledge, and listed below are some of the results of our current research program. None of these in themselves are particularly striking. However, the sum of our knowledge about poultry or any other field of endeavor is the continued compilation of such bits of information. The research laboratories and field stations of the Poultry Department are always open for inspection, and we are always glad to discuss with interested parties the current research program.

### Improved Objective Methods for Detecting Meat Spots in the Hen's Egg

Fluoroscopy did not prove an effective means for detecting meat spots in the hen's egg. Some fractionation of the meat spots indicated that they were protein in nature with grossly similar chromatographic patterns as shell cu-

ticle although the fractions were not quantitated. Histological studies indicated that many meat spots contain large amounts of calcium. This project has now been terminated.

(Project M-51)

### Relationships Between High Ambient Temperatures and Shell Thickness of Eggs

Shell-thickness problems are very serious during summer months in many poultry flocks. This problem has been approached in various ways previously. Very little work has been done on the blood, other than calcium studies in the past. Under this project, the acid-base balance of the blood was studied. It was found that when birds were held in an atmosphere of high carbon diox-

ide the shells became very thin. There was also a drop in blood pH. Further work is under way to study the  $\text{pK}$ ,  $\text{HCO}_3$ , and  $\text{PCO}_2$ .

Additions of vitamin C to the ration did not improve shell thickness. This is in disagreement with some other workers who have found that shell thickness can be improved by adding vitamin C to the ration.

(Project M-53)

## Effect of Ambient Temperature on Efficiency of Broiler Production

The initial project objectives were largely accomplished within the limitations of the physical facilities available. Considering the performance of broilers held between 70° and 75° F. in the temperature control rooms as 100, the relative weight gain for broilers from 5 to 8 weeks held at 50°, 55° and 90° F. was 78, 99, and 71 percent respectively. Similarly, the energy intake at 50°, 55°, 75°, and 90° C. was 107, 118, 100, and 77 percent. Carcass fat content ranged from 48 percent at 50° F., 74 percent at 55° F., and 104 percent at 90° F., in relation to 100 percent (considered as reference) at 70° to 75° F. Percent energy retention

amounted to 56, 73, 100 and 97 percent on a relative basis at 50°, 55°, 75°, and 90° F. The relative humidity in the rooms maintained at 50° and 55° F. was extremely high, so that these temperatures cannot be transposed directly to apply to conditions in broiler houses. This work involved considerable carcass analysis which was not included as a part of the original project outline. The results show, as indicated above, that broilers reared at cool ambient temperatures have appreciably less body fat, as compared with those at normal or high ambient temperatures.

(Project M-301, NE-8)

## Vitamin E and "Enlarged Hocks" in Turkey Poulets

In a continuing investigation of the causes of leg trouble in turkeys, tests with vitamin E-free diets have indicated convincingly that a deficiency of this vitamin does not result in the enlarged hock disorder when other factors, such as choline, manganese, zinc and niacin are supplied in adequate amounts. The

results have indicated that if the young poult has any specific need for vitamin E the requirement must be extremely low. It has been clear in these tests that rancidity in the feed can have disastrous effects and that an effective antioxidant is a desirable safeguard ingredient in all rations. (Project M-201)

## Effect of Zinc Deficiency on Male Sex Development

Moderate deficiencies of zinc slow up the overall development of male chickens and result in delayed sexual maturity. Studies are being directed to determine if severe zinc deficiency results in degenerative changes in the sex organs of the male chick similar to those seen in rats.

(Project M-203)



Effect of zinc deficiency seen in the stunted bird. The two were fed the same diet, except that 40 ppm. of zinc was added to the ration of the other bird.

## **Quality Retention in Poultry Meats as Influenced by Methods of Processing**

Feather removal in processing of poultry meat is a costly process. The birds must be immersed in hot water to remove the feathers, causing the meat to become somewhat tougher and it may even increase the bacteria counts on the carcass.

Several approaches were tried to make feather removal easier. Birds were held at low temperatures, simulating winter conditions (40° F.), and then processed. It was found that feather removal was more difficult under these conditions. It was also noted that there was more carcass discoloration. When the birds were held at temperatures as high as 160° F. prior to slaughter, the feather removal became slightly easier.

Previously it had been observed that

feather removal became slightly more difficult when birds were killed in an atmosphere of high CO<sub>2</sub>. A few birds were held in a high CO<sub>2</sub> atmosphere overnight and then a few feathers were plucked. After this treatment, it was almost impossible to remove the feathers by plucking.

Other ways have been tried to improve processing methods. A method was initiated to check samples of birds for various grade defects. By this sampling method and merely applying corrective actions, the Grade A birds were increased 30 percent by mostly eliminating misbleeds, feathers, broken bones, and other operational errors.

*(Project M-100)*

## **Calcium Requirement of Turkey Poult**

Recent findings have shown that the need of turkeys of all ages for calcium are much lower than has been thought. The previous recommendation of 2 percent calcium for starting poult is much higher than necessary and may even be detrimental because of the effect of

calcium in lowering the absorption of other minerals. In experiments at the University, 1.5 percent calcium has been found to be sufficient for turkey starters and the results suggest that even this level is considerably higher than is needed.

*(Project M-203)*

## **Nutrition and Bone Anomalies in Chicks**

Raw wheat germ meal was found to be highly detrimental to the growth of young chicks. Subsequent studies indicated that the depressant effect could be destroyed by heat treating. The work is indicative the presence of a thermolabile factor(s) similar in action to that found in raw soybeans.

Other studies indicated that the need

for folic acid by the chick varied directly with the dietary protein level. High protein levels used in conjunction with diets marginal in folic acid were severely growth-depressant and caused perosis; however, this effect could be overcome by increasing the folic acid in the diet.

*(Project M-204)*

## **Improving Performance by Breeding for Differences in Level of Chemicals in the Blood**

Two projects are concerned with the relationship between productive traits

in the chicken and the level of alkaline phosphatase and cholesterol in serum.

Statistical analyses have revealed that there is a relationship between the alkaline phosphatase level in the serum of the young chick and its subsequent egg production. A line has been developed with a high level of this enzyme. This line has laid eggs at a somewhat higher rate during the past 3 years than an unselected control. The results suggest that it might be possible for breeding farms to use chemical analyses of enzymes in their breeding programs as an aid to selecting birds with a high potential for egg production.

Similar work has been done with serum cholesterol. Results have not been very consistent. Statistical analysis suggests that certain relationships exist between cholesterol and productive traits, but the performance of the high and low serum cholesterol lines has been essentially similar. However, the age at first egg was greater for the high line than the low line. The high cholesterol line has consistently had a lower blood pressure than the low cholesterol line.

(*Projects M-32-m; M-33-e, NE-6*)

### **Semen Storage Experiments**

Fertility trials have been conducted to develop methods for storing chicken semen longer in the unfrozen state and also to develop techniques for reviving the fertilizing ability of chicken semen after it has been frozen. In work with the storage of unfrozen semen, it was found that the optimum dilution rate during storage is approximately 1 to 4. The dilution rate of 1 to 10 used previously at this laboratory was too great.

Work investigating the possibilities

of storing chicken semen in the frozen state has continued. A technique has been developed using glycerol. A temperature of 10° to 15° C. is maintained throughout the entire procedure. This results in excellent motility of the spermatozoa following freezing at -79° C. However, the resulting fertility is still disappointing, and other compounds to protect against freezing and variations in techniques are being investigated.

(*Project M-300*)

### **Effect of Protein Adequacy on the Efficiency of Selection for Early Fattening of Turkeys**

A new turkey project has been undertaken to determine the influence of protein adequacy on the efficiency of selecting for improved rate of growth and improved rate of fattening. One of the troublesome points in raising market turkeys is to have the birds adequately fattened by the time they have begun to decrease in rate of growth. Feed conversion is primarily a factor of growth rate, and if birds have to be maintained for several weeks after growth has begun to decrease markedly, feed efficiency will be greatly impaired.

Half of each group of siblings this year were fed diets differing in protein adequacy between the 4th and the 8th week of age and their rate of gain recorded during this period. As would be expected, those families which grew most rapidly on the low protein diet also grew most rapidly on the adequate diet. Generally speaking, however, there were some family differences exhibited. In subsequent years, the two lines will be maintained genetically isolated and selection will be based on the rate of gain during the 4- to 8-week growing period on the two dietary regimes to

determine if selections so influenced by lack of adequate protein will facilitate the production of a strain of turkeys

which has a tendency to overconsume and thus fatten at an early age.

(Project M-400)

## **Microbiological Studies Pertaining to Poultry Nutrition**

The synthesis of fatty acids by a single cell, free-living animal, *Tetrahymena pyriformis*, can be directed to some extent. The addition of the branched-chain isobutyric acid to the synthetic medium led to the formation of several long-chain iso-fatty acids. Another series (anteiso) of branched long-chain fatty acids were formed when alpha-methyl-n-butyric acid was supplemented. Odd numbered long-chain fatty acids were formed from sodium propionate and even numbered fatty acids from sodium acetate. *Tetrahymena* also synthesizes good amounts

of the unsaturated fatty acids, oleic, linoleic and linolenic. The last two acids are important in animal nutrition. This organism should be of interest in fundamental fat metabolism studies.

In contrast, the parasitic, disease-producing protozoan, *Trichomonas gallinae*, is unable to synthesize a variety of fatty acids, and requires them for growth. The contrast between the lipid metabolism of free-living and parasitic protozoa suggests that the lack of lipid-synthesizing enzymes is tied up with the ability of the Trichomonads to produce disease.

(Project M-48)

## **Inhibitors of Chick Growth**

Studies have continued on the growth-depressing effect of hemin, protoporphyrin and hematoporphyrin. The first two compounds result in bowed legs in a large percentage of survivors. These bone deformities have been studied to see if they are related to other bone malformations which occur in the chick from nutritional deficiencies.

While certain aspects of the porphyrin-induced deformity resemble those from nutritional origin, histological studies indicate that other mechanisms are involved. These compounds should be valuable in determining some of the mechanisms involved in normal bone metabolism.

(Project M-49)

## **Energy Intake Affects Egg Size**

Eggs which averaged 1.8 to 2 grams heavier were produced by pullets fed practical-type rations which had been up-graded in energy density. This increased potency, achieved primarily by the addition of 10 percent of corn oil, resulted in from 6 to 8 percent increase in caloric intake of pullets during the first few weeks of production. When pullets were fed a restricted amount of feed so that equalized energy intakes

resulted, no difference in egg size was observed. This indicates that the cause of the increased egg size was due to an increased energy intake rather than that of another nutrient. The use of unusually high energy diets during early production offers a means of increasing the egg size during that period when small eggs are a serious economic handicap.

(Project M-35-m)

## Higher Calcium Intakes for Layers

More extensive studies on calcium requirements of high-producing laying hens, with levels ranging from 2.27 to 4.32 percent of the total ration, have shown that levels of calcium higher than that recommended by the National Research Council improved eggshell quality and have no detrimental effects on feed intake or egg production. From these studies, it appears

that high-producing layers require approximately 3 percent total calcium in the ration, although this will vary with egg size, type of feed, production level and ambient temperature. All of the rations contained 1.25 percent stabilized fat in order to prevent these high limestone rations from being unduly dusty.

*(Project M-35-m)*

## Laying Hens Need Less Phosphorus

Studies with laying hens housed in floor pens and in cages reveal that 0.5 percent total phosphorus is ample in practical-type rations. In fact, 0.4 percent phosphorus appeared to be as satisfactory as higher levels for caged birds, based on egg production, feed efficiency, egg size, shell thickness and breaking

strength observations. This amount was supplied largely by corn and soybean oil meal (0.3 percent) with only 0.1 percent phosphorus from dicalcium phosphate. Varying the calcium level from 2.28 to 4.33 percent of the ration did not influence the total phosphorus requirement. *(Project M-35-m)*

## Methionine Requirement Equation for Layers

From previous work conducted at the University of Maryland, the methionine requirement of laying hens has been expressed as an equation in terms of the methionine needed for maintenance of body weight, increase in body weight and egg production. This equation has been tested in practical-type studies this past year with actual intakes ranging from 89 to 100 percent of predicted needs. Similar calculations for energy requirements of layers have yielded intakes from 95 to 99 percent of predicted needs. By calculating the energy and methionine requirements of laying hens, it is possible to consider differences in body weight, rate of gain, temperature, egg size, production level, energy content of the feed, and amino acid quality

in arriving at an estimate of the methionine requirement needed in a specific formula. This approach is considered to have many advantages as a means of determining the requirement for methionine of laying hens. The needs of the other essential amino acids, then, may be estimated using the proportion of these in egg protein as a guide.

This work is of particular practical significance since almost all diets for laying hens, composed of corn and soybean meal, become first limiting in methionine as protein levels are lowered. By insuring an adequate methionine level, it is possible to materially reduce the protein content of the ration and thereby improve the efficiency of protein utilization. *(Project M-202)*

## Laying Diets Compared in Floor Pens v. Cages

A series of laying rations, fed to hens kept in floor pens or laying cages, have

consistently produced poorer results in cages. Egg production averaged 8 per-

cent less for hens in cages during a 42-week period. Various dietary supplements, including egg yolk, additional vitamins and minerals, and certain amino acids, have been tested in an effort to determine if this difference is

due to a suboptimal ration for birds not having access to litter. Although better results were obtained with certain additions, these will be repeated so that definite conclusions can be made.

(Project M-35-m)

## Improved Protein Utilization by Hens

In diets where fish meal protein was used or where additional methionine was added to supply the first limiting amino acid for laying hens, protein levels as low as 13.3 and 13.7, respectively, have been used with good results. Similar studies with broilers have also shown that protein levels may be re-

duced slightly if amino acid requirements are met. The requirements of broilers for essential amino acids have been expressed directly as a function of energy content of the ration, rather than meeting these needs by requiring a minimum of crude protein.

(Project M-202)

## Methionine and Cystine Needs of Broilers

Studies with male broiler chickens using practical-type corn soybean meal rations show that the methionine requirements are met when 1.27 and 1.15 grams of methionine are supplied per megacalory of metabolizable energy

during the starting and finishing period, respectively. The total sulfur amino acid requirement appears to be 2.4 and 2.2 grams per megacalory of metabolizable energy, respectively, during these periods.

(Project M-202)

## Growth Stimulatory Value of Fats Studied

In practical-type studies with broiler chickens, several fats, including crude soybean oil, corn oil, hydrolyzed animal and vegetable fat, yellow animal grease, animal tallow, mixed vegetable oils, cottonseed soap stock, and fat supplied by toasted unextracted soybeans, failed to show any difference in growth stimulating value. In fact, it appears that

there is no specific growth stimulatory value of fats in practical feeds which are pelleted. The growth response which normally occurs from the addition of fat to a non-pelleted feed presumably is due to a large extent to the increased nutrient potency and subsequently greater feed intake by the bird.

(Project M-200)

## Antibiotics Compared for Growth Stimulation

Several trials involving floor-pen and battery-reared broiler chickens in which the antibiotics, virginiamycin, chlortetracycline, oleandomycin, spiramycin, zinc bacitracin, tylosin, procaine penicillin, spoutin, oxytetracycline, and erythromycin were compared at the different

levels. Although virginiamycin appeared to give consistently better results than the others in most trials at various levels, it was noteworthy that almost all of the antibiotics gave an appreciable response when birds were maintained on used litter. Almost no response was

observed, however, when broiler chicks were maintained on new litter or housed in batteries except from virginiamycin. These results would indicate that most antibiotics are of value in stimulating growth under practical

conditions since most of commercial conditions would be more nearly similar to those encountered in the test wherein used litter was employed.

(Project M-200)

### **Vitamin A Level Influences Severity of Coccidiosis**

The use of different levels of vitamin A in the feed either during or prior to the exposure of growing chicks to coccidiosis (*E. acervulina* or *E. necatrix*) resulted in an appreciable reduction in the severity of the disease, as measured

by difference in weight gain. The addition of 3600 I. U. of stabilized vitamin A per pound of feed was almost as effective as was a higher level.

(Project M-201)

### **Economic Effect of Body Lice on Poultry**

There have been a number of conflicting reports of the effect of louse infestation on layers, with egg production the most in question. In experiments over 2 successive years, it was found here that louse-infested birds laid almost as well as louse-free birds. In the first year, louse-free birds laid at the rate of 59.7 percent (hen-day basis) and louse-infested birds, 58.0 percent. During the second year, the production of louse-free birds was 60.9 percent and that of louse-infested birds was 60.0 percent. In the first experiment, louse-infested birds led the controls for the first 12 weeks, but the opposite was true in the second experiment. These differences were not significant statistically. There was no difference in either hatchability or egg size, but in hatchability as in total egg production, differences, though small, were tipped slightly against those having lice.

There was a slight but nonsignificant difference between layers having many lice and those having few lice when measured by egg production in the three weeks subsequent to the observation. These figures were 9.7 for low infestation and 9.5 for heavy infestation, the readings being taken during the closing weeks of the experiment.

A consistent and pronounced reduction in body weight gain from housing to the end of the experiment was found, and in each of the two experiments the louse-free birds gained 0.47 pound per bird more than the louse-infested. In the second experiment, 47 percent of the louse-infested birds made no gain or they lost weight during the laying year.

Most pronounced was skin or carcass damage resulting from the gnawing and blood-letting habits of this species of louse. A yellowish, scabby discoloration in pronounced cases was found resulting in severe loss of market grade. There was also a significant increase in mortality in louse-infested birds during the somewhat longer second experiment.

Since lice can be controlled at low cost and their detrimental effects vary from mild to severe, also since we were unable to show any possible benefits by artificial stimulation, it becomes more apparent that lice should be controlled to prevent a possible loss in egg production, an increase in mortality, severe weight loss, or reduction in market grade. These observations are undoubtedly valid also in varying degrees for broilers and turkeys.

(Project M-56)

## VETERINARY SCIENCE

Veterinary research projects are chosen on the basis of importance of the disease in relation to the economics of the livestock and poultry industries and to the health of the human population. Some research studies are also carried out to determine whether or not full-scale projects are required for the future.

### Studies on Respiratory Disease of Chickens

The standard procedure for the diagnosis of infectious bronchitis (IB) in chickens employs the serum-neutralization (SN) test in embryonating chicken eggs. Though the SN test is accurate, it is costly and time-consuming. Since from 40 to 80 chick embryos must be employed for each suspected blood sample, the number of tests that can be conducted on each flock of chickens is necessarily limited. A more economical method of diagnosis that can be applied to a larger number of birds in the flock, therefore, is desirable.

It has been found possible to produce a test-tube reaction between the infectious bronchitis virus (IBV) and a suspension of red blood cells (sheep) when the cells are first sensitized with a solution of tannic acid and then per-

mitted to adsorb IB virus. The optimum pH for adsorption of virus had been found to be 6.4. When blood serum containing antibodies against bronchitis is mixed with red blood cells thus treated, clumping (passive hemagglutination) occurs. A positive reaction is indicated by the formation of a blanket of cells on the bottom of the test tube or by clumping when tests are subjected to centrifugation and subsequently resuspended by shaking. Glucose in fluid employed to preserve suspensions of sheep red blood cells has been found to interfere with accuracy of the test. The rise and fall of serum titers in 12 experimentally infected chickens has been found to be proportional to the standard SN test.

(Project D-52)

### Equine Encephalitis

As a result of surveillance efforts and the application of newer laboratory techniques, it was possible to confirm 13 out of 17 cases of equine encephalitis in Tidewater Maryland, in 1960. The affected horses and ponies were observed during August and September. Shortly after the cessation of the disease in Maryland, an outbreak occurred in ponies on Chincoteague and Assateague Islands in Virginia, and researchers from the University of Maryland were called on to investigate the disease. Prompt confirmation was obtained, and these initial studies led to the develop-

ment of an extended cooperative investigation involving the University of Maryland, Walter Reed Army Institute of Research, and Fish and Wildlife Service (U. S. Dept. of Interior).

In studies employing burros as test animals, it was found that those injected with a vaccine strain of VEE virus resisted subsequent exposure to a field strain of EEE virus. This significant finding could have application in the protection of equines against the type of virus sleeping sickness which appears every year along the Eastern Seaboard.

(Project D-57)

## Mastitis

In a study of the interaction of microorganism, dairy cow and environment, 99 herds representing 3,828 cows, (15-, 312 quarter milk samples) were given stress ratings based upon 38 specific sanitation and milking practices. This was correlated with the frequency of *Streptococcus agalactiae* in quarter milk samples. In this particular group of cows as the number of stresses due to poor milking and sanitary practices increased in the herds, the frequency with *Streptococcus agalactiae* also showed a trend toward increase.

This means that the dairyman may help prevent at least some mastitis in his herd by keeping the herd stress low through proper milking and sanitation.

Younger cows should be milked first. The dairyman should alternate two sets of rubber inflations weekly. High door sills, rocks, stumps or projecting boards must be removed. Animals should not be crowded. Slow milking is to be avoided. There should be regular consultation with a veterinarian about mastitis prevention. Milking machines should be removed immediately after milk flow ceases, and the dairyman should be familiar with the manufacturer's directions on how to use his milking machine. The relative importance of each of these and many other specific factors that may result in herd stress needs continued evaluation.

(Project D-58)

## An Investigation of "Air-Sac" Infection in Poultry

Although investigational work during recent years has brought to light much valuable data concerning to so-called "air-sac" infection of domestic poultry, a blood test for the detection and removal from the flock of carriers of this disease has not been perfected. "Air-Sac" infection is caused by the bacterial organism, *Mycoplasma gallinarum*, which also causes infectious sinusitis of turkeys and chronic respiratory disease (CRD) in chickens. Essential to the perfection of a serological test for detection of birds disseminating the disease is the selection of suitable strain or strains of the causative organism for antigen and for improved methods of propagating *Mycoplasma gallinarum* in the laboratory.

A serological study of 8 strains of *Mycoplasma gallinarum* has been carried out, employing cross-agglutination and agglutination-absorption techniques. Included in the strains selected for investigation were pathogens and nonpathogens isolated in Maryland and

in California. Three different types of fermentation reactions in carbohydrate media were exhibited by strains included in the group. With one exception, pathogenic strains and nonpathogenic strains cross-agglutinated only with members of their respective group. Rabbit serum containing antibodies against two nonpathogenic strains cross-agglutinated rabbit serum containing antibodies against pathogenic strains. On the basis of agglutination-absorption mirror tests, 3 Maryland pathogens and one California pathogen were found to be identical or closely related. One Maryland pathogenic strain was found to contain an antigen not present in other pathogens. Similar tests revealed that a California nonpathogenic strain was not identical with two Maryland nonpathogenic strains. Thus heterogeneity was revealed within each group.

Physiological studies with type strains of *Mycoplasma gallinarum* were designed to determine optimum conditions for growth of the organism in labora-

tory media. A diauxie-like growth pattern was exhibited when after an initial lag-phase of 13 hours, log-phase of 27 hours, second lag-phase of 8 hours, a second log- or growth-phase of 30 hours was exhibited. This is attributed to development of adaptive enzyme by means of which the organism is able to utilize a nutrient required after exhaustion of nutrients available in initial stages of growth. Glucose concentrations in media between 0.25 percent and 1.0 percent failed to exhibit increased growth but concentrations between 1.0 percent and 3.0 percent inhibited growth. While 2 percent PPLO serum-fraction (Difco) routinely is employed

in beef-heart infusion broth for propagation of the organism, the greatest growth response was obtained with concentration of serum fraction was incorporated in media at the level of 7 percent Yeast extract as a supplement to heart-infusion broth failed to stimulate growth of a pathogenic strain of PPLO. A pH of 8.0 was found to be the optimum hydrogen-ion concentration for growth. Aeration by stirring nutrient broth with a magnomixer stimulated growth of the organism to a marked extent. In studies completed to date, growth rates have been measured by nephelometry.

(Project D-59)

### Three-Prong Brucellosis Studies

Brucellosis studies have continued to be concerned with the following three objectives: (1) Development of a technique to measure the resistance of cattle to the disease, (2) production of an immunizing vaccine that will not cloud the present diagnostic methods, and (3) finding a satisfactory curative agent.

Though Maryland's problems in the control of brucellosis have become less acute, there will undoubtedly be outbreaks of the disease from time to time, as there have been in the tuberculosis-control program. Hence, one of the main objectives in the State program is to produce a vaccine which can be used to control the disease and not interfere with the presently used diagnostic method, the agglutination test.

The most satisfactory of the several types of vaccines studied is one which is grown in embryonating eggs. The organisms used have become so adapted over a long period of time that 7-day embryonating eggs are killed within 2 days after inoculation. However, the same organisms produce only a mild attack of the disease in laboratory animals. Studies of the effect of this type of vaccine in cattle have not, as yet, been attempted.

Further data has been collected on the protective qualities of the blood sera of cattle in preventing the death of experimentally infected embryonating eggs. Several drugs have been evaluated in laboratory animals which appeared to be effective against the *Brucella* organism.

(Project D-60)

### Studies on Ketosis

Investigation of the organic acids present in the livers of sheep with pregnancy disease continues. The major effort of the year has been devoted to the separation of the acids in pure frac-

tions and their identification. It is apparent that the concentration of several of these acids differs from normal in the affected sheep.

(Project D-61)

## **Pathology of Breeding Failures in Cattle**

**Vibriosis:** The direct isolation from carrier bulls of vibrio causing infertility has been an uncertain procedure that required large quantities of media and several weeks to complete. Overgrowth from the wide variety of saprophytes in the normal flora was the principal problem. Therefore culturing from virgin heifers test-mated to carrier suspects has been the only alternative method of detecting these bulls. This procedure, never reliably established as adequate, required 4 weeks to complete in test animals that are rarely available.

A filtration method has been devised to overcome these difficulties. The optimum inoculum, filter sizes, and filtrate fractions useful for isolation of vibrio from the prepuce have been established in 101 filter trials. Isolations were made from 25 of 30 samples from 4 carrier bulls with this method. Only 2 blood agar plates were required for each

### **Leptospirosis**

As a result of previous serological surveys of Maryland cattle, it appeared that there had been significant infection involving a number of leptospiral strains for which no commercial vaccines are available. A number of these strains, from the *L. heboomadis* group, were used to infect calves experimentally. The infected calves experienced a relatively mild disease and the infecting organism could not be recovered from the urine. It was concluded from these studies and field observations that

### **Study of Bovine Respiratory Disease**

In attempts to reproduce the shipping fever syndrome commonly seen in cattle, experimental calves were transported to western Maryland and then exposed to SF-4 virus. None of the animals treated in this manner became noticeably sick, despite the fact that SF-4 virus has been incriminated in numerous outbreaks of shipping fever.

Large quantities of blood were ac-

quired from a Baltimore abattoir for analysis and possible use in preventing shipping fever. It was found that the pooled serum fractions had a high level of protective substances against viruses involved in bovine respiratory diseases. These serum fractions will be used in subsequent experiments to determine their value in preventing shipping fever.

(Project D-63)

sample. Isolation has been successful in several farm herds. The separation of vibrios of intestinal origin and saprophytic vibrios from types causing infertility has been uncertain. This situation has caused confusion and inaccurate herd diagnosis. These other vibrios have been found in all kinds of bovine samples including aborted fetuses. A system using 6 kinds of media has been devised that will identify each biotype encountered to date. The method has been very satisfactory for separating 150 cultures of vibrios of bovine origin.

Additional isolation procedures are to be studied and compared. The filtration technique can be improved and the time required for isolation and identification shortened by various methods including labeling with fluorescent antibody.

(N.E. 40 (D-62)

although leptospirosis is widespread throughout Maryland and other Middle Atlantic states, the amount of severe disease and economic loss is difficult to assess.

Experimental studies on leptospirosis in sheep revealed that sheep are highly susceptible to the leptospiral toxins. Thus, sheep may serve as a useful model for studying the disease and for applying the information obtained for control of leptospirosis in other livestock.

(Project D-62)

quired from a Baltimore abattoir for analysis and possible use in preventing shipping fever. It was found that the pooled serum fractions had a high level of protective substances against viruses involved in bovine respiratory diseases. These serum fractions will be used in subsequent experiments to determine their value in preventing shipping fever.

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# FINANCIAL STATEMENT -- JULY 1, 1960, TO JUNE 30, 1961

## Federal Funds

	Amended Hatch	Regional Research	Agrl. Marketing Title II	
<i>Appropriation 1960-1961</i>	\$ 354,691.00	\$ 99,750.00	\$ 9,500.00	
<b>TOTALS</b>	<b>354,691.00</b>	<b>99,750.00</b>	<b>9,500.00</b>	<b>9,644.01</b>
<i>Receipts from sources other than Federal 1960-1961:</i>				
State Appropriations for Agricultural Investigations .....				\$1,022,158.80
Special Endowments, Fellowships and Grants .....				52,480.15
Sales and Miscellaneous .....				150,304.17
				<u>1,224,943.12</u>
Balance brought forward July 1, 1960 .....				56,744.18
<b>TOTAL</b>				<b>1,281,687.30</b>
<i>Expenditures:</i>				
Personal Services .....	239,903.13	67,509.01	8,030.21	821,711.57
Travel .....	4,649.11	1,951.05	372.42	14,167.38
Transportation .....	506.31	103.33		809.24
Communication, Service .....				4,203.91
Rents and Utility Services .....	616.89	145.75		
Printing and Reproduction .....	1,967.60	1,044.49		16,346.77
Other Contractual Services .....	4,100.45	124.59		
Supplies and Materials .....	9,123.42	2,388.89	6.50	2,878.03
Equipment .....	57,501.26	15,637.70	110.38	45,432.90
Lands and Structures .....	36,322.83	10,229.22		241,877.84
Contributions to Retirement .....				37,564.39
Taxes and Assessments .....				28,081.80
				<u>550.22</u>
Balance June 30, 1961 .....				1,213,624.05
<b>TOTALS</b>	<b>354,691.00</b>	<b>99,750.00</b>	<b>9,644.01</b>	<b>68,063.25</b>

\* Including Offset Funds.

## PUBLICATIONS

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470 Row Widths and Seeding Rates in Soybeans. R. C. Leffel and G. W. Barber, Jr. 18 pp. June, 1961.

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398 Factors Affecting Market Outlet Shifts of Fluid Milk Producers. G. M. Beal. Multigraphed Circular. 44 pp. September, 1960.

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417 Market Analysis for Distribution of Dressed Poultry in Baltimore-Washington Area. H. D. Smith. Multigraphed Circular. 40 pp. April, 1961.

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#### Department of Dairy Science

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## CURRENT PROJECTS

### Project No.

(These are projects and not publications available to the public)

#### Department of Agricultural Economics

A-18-am An Analysis of Alternative Adjustments in Farm Organization. Sidney Ishee and G. N. Nichols, Jr.

A-18-an An Economic Analysis of Cage and Floor Methods of Commercial Egg Production. R. A. Murray.

A-18-ao An Analysis of Forage Storage on Dairy Farms. J. W. Wysong.

A-18-ap Economic Profitability of Vegetable Production in Maryland. Sidney Ishee.

A-18-aq Economic Effects of Vertical Integration on the Production and Marketing of Maryland Farm Products. Sidney Ishee.

A-18-ar Economies of Scale in the Production of Fluid Milk on Specialized Dairy Farms in Maryland. J. W. Wysong and Phillip Stowell.

A-19-v An Analysis of the Distribution of Highway-User Taxes for Rural and Urban Highways in Maryland. W. P. Walker.

A-19-w Comparison of Tax Resources, Efforts and Sacrifices Among Counties in Supporting County Functions in Maryland. W. P. Walker.

A-19-x Impact of Highway Programs Upon Economic Development of Areas in Maryland. W. P. Walker.

A-26-az An Economic Analysis of Soybean Marketing In Maryland. C. C. Taylor and Bhagwant Singh.

A-26-b Membership Relations and Educational Programs of Farmer Cooperatives in Maryland. R. J. Beiter.

A-26-ba Sales Organizational Aspects of Quality Control in the Marketing of Fruits and Vegetables. D. A. Swope, F. R. Todd, Jr., and P. F. Brown.

A-26-bb Impact of Recent Trends in Specification Production and Buying of Livestock on Market Organization and Services. H. D. Smith and J. N. Smith.

A-26-bc Adjustments of Maryland Milk Processing-Distribution Systems and Practices to Changing Conditions. G. M. Beal and Ray Fox.

A-26-bd Adjustments in Broiler Industry Related to Area Competition and Market Demand. H. D. Smith and grad. assistant.

A-26-be A Market Analysis for Distribution of Dressed Poultry in the Baltimore-Washington Area. H. D. Smith and Nazar Elissa.

A-26-bf Improving Auction Warehouse Facilities and Methods of Marketing Maryland Tobacco. G. M. Beal and R. M. Jones.

#### Department of Agricultural and Extension Education

T-6 Identification of High School Educational Experiences Affecting the Success of Students in the College of Agriculture. Clodus Smith and Glenn Baird.

#### Department of Agricultural Engineering

R-11-e Structures and Equipment for Tobacco Stripping. P. N. Winn, G. J. Burkhardt, J. H. Hoyert and O. E. Street.

R-11-f Mechanization of Tobacco Harvest. P. N. Winn, G. J. Burkhardt, R. L. Green, E. W. Martin, N. Martin, J. H. Hoyert and J. Berlijn.

R-16 Pneumatic Handling of Chopped Forage. K. E. Felton, G. J. Burkhardt, E. W. Martin and John Foster.

R-18 Development of Equipment and Improved Methods for Harvesting Sweet Potatoes. G. J. Burkhardt, E. W. Martin, L. E. Scott and H. S. Todd.

R-20 Principles of Separating Crop from Soil in Harvesting Root Crops. G. J. Burkhardt, Paul Winn, E. W. Martin, L. E. Scott and H. S. Todd.

R-21 Development and Construction of Specialized Facilities and Equipment for Use in Agricultural Research. G. J. Burkhardt and E. W. Martin.

RB-11-g Tobacco Housing. (In cooperation with the Department of Agronomy) O. E. Street, John Hoyert, P. N. Winn, G. F. Burkhardt, R. L. Green, E. W. Martin and N. Martin.

## Department of Agronomy

B-43 Soybean Varietal Improvement. R. C. Leffel and W. D. Hanson.  
B-50 Breeding for Better Dent Corn. R. G. Rothgeb and staff assistants.  
B-56-g Ladino Clover Breeding Disease and Insect Investigations. R. C. Leffel.  
B-56-i Breeding and Evaluation of Improved Varieties of Orchard Grass and Other Forage Crops. R. C. Leffel.  
B-56-j Pasture Species for Beef Production. A. M. Decker and J. E. Foster.  
B-66 Wheat Breeding and Evaluation. R. G. Rothgeb, J. L. Newcomer and J. H. Axley.  
B-67 Varietal Improvement in Barley and Oats. R. G. Rothgeb and assistants.  
B-68 Effect of Rotational Practices Involving Various Legumes on the Growth, Quality and Composition of Maryland Tobacco. O. E. Street, C. G. McKee, J. H. Hoyert, J. E. McMurtrey, Jr., and J. D. Bowling.  
B-70 A Study of the Growth Characteristics of Foxtail (*Setaria* spp.) as Related to Chemical Control Measures. P. W. Santelmann, J. A. Meade and N. C. Glaze.  
B-71 Performance of Grain Sorghum Hybrids in Maryland. R. G. Rothgeb and assistants.  
B-72 Evaluation of Varietal Purity and Identity of Seeds of Improved Strains of Alfalfa. J. L. Newcomer.  
B-73 Clipping Management Effects on the Productivity and Persistence of Perennial Grasses Under Two Nitrogen Levels. A. M. Decker, N. A. Clark and J. T. Raese.  
B-74 The Effects of Nitrogen Rates and Clipping Frequency on the Performance of Midland Bermudagrass (*Cynodon dactylon* (L) Pers.) A. M. Decker.  
B-75 Use of Sod-seeded Forage Crops to Supplement Existing Permanent Pastures. A. M. Decker, F. G. Swain, W. C. Hulbert and A. L. Steinhauer.  
B-76 Red Clover Breeding Investigations. R. C. Leffel.  
B-77 Forage Crop Variety Evaluation in Maryland. R. C. Leffel, A. M. Decker and N. A. Clark.  
B-78 The Control of Weeds in Cultivated Crops, Turf and Brush. P. W. Santelmann, J. A. Meade and N. C. Glaze.  
B-79 Use of Herbicides to Control Weeds in Forages. J. A. Meade and P. W. Santelmann.  
B-80 Physiological and Ecological Investigations of the Effect of the Herbicides on Plants. J. A. Meade and P. W. Santelmann.  
B-81 Preplant Herbicides for Tobacco Plant Beds, and their Influence on Seedling Production. O. E. Street, O. D. Morgan, Jr., J. H. Hoyert, J. E. McMurtrey, Jr., and H. E. Heggestad.  
B-82 Fertility and Clipping Management Effects on the Productivity and Persistence of Annual Pasture Grasses. N. A. Clark.  
B-83 Forage Crop Development Under Controlled Soil Temperature Conditions. A. M. Decker and N. H. MacLeod.  
B-85 Late Planting and Winter Survival in Oats. R. G. Rothgeb, and assistants.  
B-87 Factors Contributing to Maximum Production in Maryland Tobacco. O. E. Street, J. H. Hoyert, J. D. Bowling and J. E. McMurtrey, Jr.  
B-89 Studies of Some Fundamental Physicochemical Relationships of Tobacco with Respect to Cultural, Fertilization, Curing and Fermentation Practices. R. G. Rothgeb, grad. assistants, T. C. Tso, R. N. Jeffrey, J. E. McMurtrey and H. M. Tysdal.  
IG-2 Grazing Study with Lactating Dairy Cows on Summer Annual Pastures. N. A. Clark, R. W. Hempken and J. H. Vandersall.  
IQ-83 Yield and Quality of Selected Crops Receiving Supplemental Irrigation, Including Relationships of Moisture to Species, Fertilizers and Cultural Practices. (In cooperation with Department of Horticulture) A. M. Decker, Jr., E. Strickling and O. E. Street.  
OQR-84 Climatological Relationship to Plant Growth Employing Supplemental Irrigation. (In cooperation with Departments of Agricultural Engineering and Horticulture) O. E. Street, A. M. Decker, Edward Strickling, C. W. Reynolds, P.

N. Winn, M. L. Blanc, H. H. Engelbrecht, C. A. Britt, H. E. Heggested, J. E. McMurtrey and J. K. McGuire.

O-48 Morphologic Studies of Maryland Soils as Related to Classification and Correlation. G. A. Bourbeau, W. Winant and J. A. Pomerening.

O-54 Clay and Secondary Mineral Genesis in Maryland Soils. G. A. Bourbeau, Shiraj H. Khan and Lee Moser.

O-55 Soil Test Studies. John Axley and Clifford Simonson.

O-56 Factors Affecting the Formation and Destruction of Soil Aggregates. Edward Strickling, Jack Conaway and George Malley.

O-57 A Study of Ammonium as a Fertilizer and Ammonium Retention in Soils. J. H. Axley.

O-59 Response of Orchardgrass to Various Rates and Ratios of Potassium and Nitrogen Fertilization. C. B. Kresge.

O-60 The Effect of Various Rates and Frequencies of Potassium Applications on Yield, Persistence and Chemical Composition of Alfalfa and Alfalfa-Orchardgrass. C. B. Kresge.

O-61 Comparison of the Effect of Several Nitrogen Sources on Yield and Nitrogen Content of Grass Under Field Conditions. C. B. Kresge.

O-62 The Response of Forages and Certain Grain Crops to Fertilizers as Related to Rates and Ratios and Methods of Application. J. H. Axley.

O-63 Response of Orchard Grass to Various Sources of Nitrogen and their Time of Application. C. B. Kresge.

O-64 Response of Bermudagrass to Various Rates and Ratios of Potassium and Nitrogen Fertilization. C. B. Kresge, A. M. Decker and N. A. Clark.

#### Department of Animal Husbandry

C-14 A Study of the Productiveness of Purebred Beef Cattle in Maryland. W. W. Green, John Buric and J. E. Foster.

C-14-a Effect of Early Weaning on the Duration of Maternal Influences in Beef Calves. W. W. Green, John Buric and W. J. Corbett.

C-14-d Group Versus Individual Feeding of Weaned Beef Calves. John Buric, J. E. Foster, and W. W. Green.

C-21 The Effect of Specific Metabolites Upon Growth Rate and General Condition of Sheep. E. C. Leffel, S. M. Meredith and P. H. Engle.

C-25 A Study of Rumen Metabolism in the Sheep. E. C. Leffel, R. J. Komarek, L. W. Smith and J. E. Foster.

C-25-a The Effects of Roughage Preparation. E. C. Leffel, L. W. Smith and J. E. Foster.

C-28 A Study of the Effect of the Form in Which Feeds are Fed to Swine. E. P. Young, F. C. Wingert and J. E. Foster.

C-31-a Comparison of Pelleted versus Unpelleted Barley for Feeding Weaned Beef Calves. John Buric, J. E. Foster and E. C. Leffel.

C-31-b Comparison of Morea versus Oil Meal as a Supplement for Feeding Weaned Beef Calves. John Buric, J. E. Foster and E. C. Leffel.

C-32 A Study of the Value of Systemic Insecticides in the Control of Ox Warbles, *Hypoderma lineatum* (DeVill.) and *H. bovis* (L.). John Buric, J. E. Foster, E. C. Leffel and W. T. Johnson.

C-33 A Study of the Effect of Menhaden Fish Meal on the Quality of Protein of Swine Diets and on Total Crude Protein Requirements for Growth of Swine. E. P. Young, J. E. Foster, D. G. Snyder and R. R. Kifer.

C-34 A Study of the Nutritional and Physiological Influences on Variability of Ovulation Rate and Embryonic Survival in Swine. E. P. Young, W. W. Green, W. W. Martel and J. E. Foster.

C-35 Studies on the Efficiency and Composition of Growth in Swine as Affected by Protein and Energy Consumption. E. P. Young, E. C. Leffel, W. W. Martel, J. E. Foster and G. F. Combs.

C-36 A Study of Factors Affecting the Utilization of Non-protein Nitrogen in High Roughage Diets for Ruminants. E. C. Leffel and N. Satapathy.

C-37 A Comparison of Different Roughage Grain Ratios for Optimum Gains for Developing Weanling Beef Heifers. John Buric, J. E. Foster and E. C. Leffel.

### Department of Botany

F-12 The Native Plants of Maryland, Their Occurrence, Distribution and Economic Importance. R. G. Brown and M. L. Brown.

F-17 Forest Tree Improvement by Chromosome Doubling of Haploid Sporophytes. R. D. Rappleye.

F-18 Genetic Control of the First Division Association of Homologous Chromosomes and Fertility in *Zea Mays* and *Capsicum frutescens*. D. T. Morgan.

J-91 Fungicidal Materials on Cellular Metabolism and Their Usefulness for the Field Control of Vegetable Diseases. H. D. Sisler, J. G. Kantzes, R. A. Pater-son and graduate assistants.

J-93 Treatment of Soil and Underground Parts of Plants for the Control of Plant Diseases. O. D. Morgan, J. G. Kantzes, L. R. Krusberg, J. B. Wilson and R. C. Leffel.

J-95 Development of Improved Strains of Maryland Tobacco Resistant to Diseases. O. D. Morgan, O. E. Street and John Hoyert.

J-96 Occurrence, Distribution, Biology and Control of Plant Parasitic Nematodes in Maryland. W. R. Jenkins, R. A. Rohde, J. G. Kantzes, O. D. Morgan and L. R. Krusberg.

J-97 Physiology of Plant Parasitic Nematodes and the Plant Nematode Interaction. L. R. Krusberg and graduate assistants.

J-98 Identification, Characterization and Control of Certain Viruses Affecting Eco-nomic Plants in Maryland. H. D. Sisler and O. D. Morgan.

J-99 The Nature and Control of Root Rots Involved in Decline of Boxwood and Other Woody Ornamental Plants in Maryland. J. B. Wilson and L. R. Krus-berg.

J-100 Nature and Control of Major Field and Storage Diseases of Sweet Potatoes in Maryland. J. G. Kantzes and graduate assistants.

K-8-c Biophysical and Biochemical Factors in Plant Nutrition. H. G. Gauch, R. W. Krauss, Raymond Gallaway, M. D. Mathes, L. Carleton, L. Hare and J. Bowen.

### Department of Dairy Husbandry

G-34 Chemical Changes in Milk Fat as Related to the Flavor of the Milk. R. L. King and Mark Keeney.

G-35 The Analysis of Dairy Products. Mark Keeney and L. A. Wishner.

G-37 Physiology of Metabolic Diseases of Cattle. W. F. Williams, R. W. Hemken, W. H. Choate, H. H. Head and S. D. Lee.

G-38 The Endocrine Regulations of Glucogenesis and Glucose Metabolism as Related to Milk Secretion. W. F. Williams, R. F. Davis, H. H. Head and J. D. Connolly.

G-39 Studies on the Mode of Digestion, Absorption and Utilization of Feeds by Ruminants and their Associated Bacteria. W. E. Stewart, R. N. Doetsch and R. F. Davis.

G-40 Influence of High Temperature Heat Treatment on Certain Physical and Chemical Properties of Milk. J. F. Mattick and Mark Keeney.

G-42 Methods of Processing and Other Factors Affecting the Quality of Ice Cream. W. S. Arbuckle and William Venter.

G-46 The Relationship of the Hypophyseal Growth Hormone and of the Pituitary-Adrenal System to the Productive Capacity of Dairy Cattle for Reproduction and Milk Production. W. F. Williams and S. D. Lee.

G-47 The Nutritive Evaluation of Forages. R. W. Hemken, R. F. Davis and N. A. Clark.

G-48 Flavor Quality of Concentrated Milk Products as a Factor in Milk Utili-tion and Marketing. Mark Keeney.

G-50 The Physiology of Mammary Gland Growth and Development and the Initiation and Maintenance of Lactation with Particular Reference to Endocrine Relationships. W. F. Williams and G. D. Turner.

G-51 A Study of the Effects of Pelleting and Heating of Feeds Upon Body Compo-sition, Growth and Milk Secretion in Ruminants. R. W. Hemken, R. L. King and J. H. Vandersall.

G-52 A Study of Factors Affecting the Voluntary Intake, Availability and Utilization of Nutrients in Forages for Growth and Milk Production. J. H. Vandersall, R. W. Hemken, N. A. Clark and R. F. Davis.

G-53 A Study of the Development, Improvement or Standardization of Manufacturing Processes for the Production of Various Cheeses and the Effect of Specific Factors on the Flavor, Body and Texture of these Cheeses. J. F. Mattick.

GC-45 Studies on the Physiological and Biochemical Nature of Bloat. (In cooperation with Department of Animal Husbandry) W. E. Stewart, E. C. Leffel, R. J. Komarek, J. E. Foster and R. F. Davis.

BG-1 The Comparison of Nitrogen Fertilized Grasses with a Grass-Legume Mixture for Lactating Dairy Cows. (In cooperation with Department of Agronomy) N. A. Clark, A. M. Decker, R. W. Hemken and J. I. Leslie.

#### Department of Entomology

H-29-n Chemical Control of Insect Pests of Sweet Corn. L. P. Ditman and F. P. Harrison.

H-35-b Nursery Insects. The Control of Arthropod Pests of Azalea with Systemic Insecticides. W. T. Johnson and W. E. Bickley.

H-46-e Continued Studies on the Efficiency of Fixed-Boom Low-Volume Sprayers and the Development of New Insecticides. L. P. Ditman, G. F. Burkhardt, J. T. Whitlaw, Jr., W. E. Bickley and graduate students.

H-48 Control of the Codling Moth and Careful Observations on Possibility of Resistant Strains. W. E. Bickley, Castillo Graham and E. R. Krestensen.

H-56 Patuxent Project on the Effect of Soil Conservation Upon Insect Populations. H. B. Owens, L. P. Ditman and W. E. Bickley.

H-61 The Biology and Distribution of *Macropsis Trimaculata* Fitch. W. E. Bickley and E. R. Krestensen.

H-64 An Evaluation of the Effectiveness of Commercial Insect Control Practices on Canning Crops. L. P. Ditman.

H-67 Insecticidal Residues on Vegetable and Forage Crops. L. P. Ditman, J. T. Whitlaw, Jr., and graduate students.

H-69 Identification and Control of the Various Species of Mites Causing Damage to Apple Orchards. W. E. Bickley, Castillo Graham and E. R. Krestensen.

H-71-a The Clover Root Curculio. W. G. Phillips, W. E. Bickley and L. P. Ditman.

H-71-c Insects Affecting Soybeans. W. E. Bickley, A. L. Steinhauer, T. L. Bissell and R. H. Ratcliffe.

H-71-d Alfalfa Insects, Their Biology and Control. A. L. Steinhauer and W. E. Bickley.

H-72 Physiology of Insect Reproduction. J. C. Jones and graduate students.

H-73-a The Mosquito Fauna in Selected Swamps, Marshes and Impoundments. W. E. Bickley, and P. M. Brickey.

H-73-c Feeding Habits of Maryland Mosquitoes in Relation to Eastern Equine Encephalitis. W. E. Bickley, R. F. Byrne and graduate students.

H-74 Biology and Control of Tobacco Insects. F. P. Harrison.

H-75 The Taxonomy of the *Aspidiotus howardi* Ckll. Complex (Homoptera: Coccoidea). J. A. Davidson and W. E. Bickley.

H-76 Comparative Morphology and Physiology of Insect Blood Cells. J. C. Jones and graduate students.

H-77 The Susceptibility of the Red-Banded Leaf Roller *Argyrotaenia velutinana* (Wlkr.) to TDE. W. E. Bickley and E. R. Krestensen.

H-78 Metabolism of Essential Nutrients and Insecticidal Chemicals in Insects. A. L. Steinhauer and graduate students.

H-79 Classification of Green Lacewings (Chrysopidae: Neuroptera). W. E. Bickley and R. A. Bram.

H-80 Classification of the Neotropical Mosquitoes of the Subgenus *Culex*. W. E. Bickley and R. A. Bram.

#### Home Economics--Department of Foods and Nutrition

Y-1 The Effect of Different Quality and/or Quantities of Dietary Protein on Serum Lipid Levels. Pela Braucher, L. M. Dyke, Virginia Dawson, Genevieve Watkins and Helen Sullivan.

## Home Economics—Department of Textiles and Clothing

Y-2 Measurements of Air Permeability on Selected Garment Fabrics Before and with Wear. Eleanor Young and T. Faye Mitchell.

### Department of Horticulture

I-74-a Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Potted Plants. J. B. Shanks, C. B. Link and Lemoyne Hogan.

I-74-b Effect of Environmental Factors and Cultural Practices on the Growth and Flowering of Greenhouse Cut Flower Crops. C. B. Link and J. B. Shanks.

I-79-j The Relationship of Growth Regulators and Certain Environmental Factors on the Flowering of the Azalea (Rhododendron). C. B. Link, J. B. Shanks and D. J. Ballantyne.

I-79-k Factors Influencing the Induction, Formation, and Development of the Inflorescence in *Hydrangea macrophylla* (Thunb.) J. B. Shanks, C. B. Link and P. L. Smeal.

L-73 Adaptation of Fruit Varieties and New Seedlings to Maryland. I. C. Haut, F. J. Lawrence and A. H. Thompson.

L-74 Environmental Factors and Cultural Practices in Relation to the Growth and Fruiting Responses of Fruits. A. H. Thompson, L. E. Scott, F. J. Lawrence, B. L. Rogers, I. C. Haut and S. H. Todd.

L-74-b Chemical Thinning of Apples and Peaches. A. H. Thompson and B. L. Rogers.

L-74-c Boron Nutrition of the Apple in Relation to the Development of Bitter Pit and of Red Color and Finish. A. H. Thompson, A. A. Hewitt, W. J. Bramlage, B. L. Rogers and H. G. Gauch.

L-79-a Relation of the Level of Mineral Nutrients in the Plant to Growth and Fruiting of the Strawberry with Particular Reference to Nitrogen. L. E. Scott, G. J. Stadelbacher, W. A. Matthews and I. C. Haut.

L-79-d Mineral Nutrition of the Apple with Reference to Growth, Fruitfulness and the Development of Internal Bark Necrosis. A. H. Thompson, B. L. Rogers, J. A. Borden, D. L. Heinicke and L. E. Scott.

Q-58-a Rapid Nutritive Evaluation of Processed Vegetables. Amihud Kramer, L. E. Scott and E. H. Ahmed.

Q-58-k Development of Specifications for Canned Food Quality. Amihud Kramer, F. C. Cooler, R. C. Wiley, B. A. Twigg, Jane Cooler and Mildred Modrey.

Q-58-m Development of New Products and Improved Processing Methods. R. C. Wiley, Amihud Kramer, B. A. Twigg, M. Modrey, T. Chase and J. Cooler.

Q-58-f Development of Objective Grades and Standards and Quality Control Method for Vegetables. Amihud Kramer, R. C. Wiley, L. E. Scott, J. Ewell and Jane Cooler.

Q-58-n Suitability of New Varieties of Horticultural Crops for Canning and Freezing. W. L. Hollis, B. A. Twigg, Amihud Kramer, F. C. Stark, L. E. Scott and R. C. Wiley.

Q-58-p Quality Improvement of Canned Apple Slices and Sauce Through Studies of the Relation of Water Insoluble Constituents of the Fresh Fruit to the Textural Quality of the Processed Product. R. C. Wiley, G. E. Stemberidge, Amihud Kramer, M. Modrey and T. Chase.

Q-58-q Bulk Packaging and Shipping of Raw Vegetables. Amihud Kramer, F. W. Cooler and B. A. Twigg.

Q-74 A Study of Regional Adaptation of Certain Vegetable Crops and Varieties in Maryland. W. L. Hollis, C. W. Reynolds, F. C. Stark, L. E. Scott, J. G. Kanzes and W. A. Matthews.

Q-77 Crop Management Studies with Vegetable Crops. W. L. Hollis, F. C. Stark, C. W. Reynolds and H. H. Engelbrecht.

Q-79-g Changes in Chemical Composition of the Sweet Potato During Development, Storage and Processing as Related to Quality of the Final Product. L. E. Scott, W. A. Matthews, F. C. Stark and R. A. Baumgardner.

Q-79-h Influence of Nutrient Intensity and Balance on the Growth, Yield and Quality of Cauliflower. C. W. Reynolds and F. C. Stark.

Q-81 Cantaloupe Breeding and Selection with Particular Reference to Quality and Resistance to Defoliation. F. C. Stark and W. A. Matthews.

Q-81-b Sweet Potato Breeding and Selection with Particular Reference to Quality and Resistance to Cracking. F. C. Stark, W. A. Matthews and L. E. Scott.

Q-81-c Sweet Corn Breeding with Particular Reference to the Utilization of Cytoplasmic Male Sterility in the Production of  $F_1$  Hybrid Seed Corn. R. J. Snyder and Gordon Johnston.

Q-82 Tomato Breeding and Selection with Particular Reference to Greater Resistance to Cracking and to Late Blight. F. C. Stark and W. A. Matthews.

BQ-83 Yield and Quality of Selected Crops Receiving Supplemental Irrigation, Including Relationships of Moisture to Species, Fertilizer and Cultural Practices. (In cooperation with Department of Agronomy) O. E. Street, A. M. Decker, J. E. Strickling, C. W. Reynolds and F. C. Stark.

QRA-1 The Retention of Market Quality of Sweet Potatoes by Improved Methods of Harvesting, Grading and Handling. (In cooperation with Departments of Agricultural Economics and Agricultural Engineering) L. E. Scott, W. A. Matthews, F. C. Stark, H. S. Todd, G. J. Burkhardt, Paul Winn and D. A. Swope.

#### Department of Poultry Husbandry

M-32-1 Study of Factors Influencing or Controlling the Onset of Molt. Mary Juhn, C. D. Quigley and C. S. Shaffner.

M-32-m Genetic Differences in Alkaline Phosphatase Concentration of Blood Sera as Related to Differences in Egg Production and Egg Quality. F. H. Wilcox, C. S. Shaffner, H. V. Auger, P. M. Macomber and H. R. Wilson.

M-33-e Genetic Control of Serum Cholesterol Level. F. H. Wilcox, C. S. Shaffner, C. E. Clark, H. V. Auger and P. M. Macomber.

M-34-e Selective Breeding of Medium Sized Turkeys for Improvement of Economic Qualities. C. S. Shaffner, G. D. Quigley and C. E. Clark.

M-35-m Development of Improved Rations and Feeding Methods for Laying Chickens. G. F. Combs, N. V. Helbacka, Ernest Bossard, James Casterline, Aaron Spandorf and C. S. Shaffner.

M-48 Microbiological Studies Pertaining to Poultry Nutrition. M. S. Shorb, Pauline Lund, W. O. Pollard and H. V. Auger.

M-49 Vitamin  $B_{12}$  and Chick Nutrition. M. S. Shorb and W. O. Pollard.

M-51 Development of Improved Objective Methods for Detecting Meat Spots in the Hen's Egg as Related to Quality in Egg Marketing. N. V. Helbacka, J. L. Casterline, Jr., and S. W. Patch.

M-53 A Study of the Relationships Between High Ambient Temperature and the Shell Thickness of Market Eggs. N. V. Helbacka, C. Smith and J. L. Casterline.

M-55 The Perception and Preference of Chickens for Different Colors. G. D. Quigley.

M-56 Effects of the Chicken Body Louse on Egg Production and Performance. C. D. Quigley.

M-100 Quality Retention in Poultry Meats as Influenced by Methods of Processing. N. V. Helbacka, S. W. Patch, J. L. Casterline, C. S. Shaffner and W. F. Bratten.

M-200 Studies on Improved Broiler Nutrition. G. F. Combs, J. L. Nicholson, N. V. Helbacka, B. Panda and R. D. Creek.

M-201 Vitamins and Unidentified Organic Factors in Poultry Nutrition. G. F. Combs, W. C. Supplee, R. D. Creek, J. L. Nicholson and D. L. Pope.

M-202 Protein and Amino Acids in Poultry Nutrition. G. F. Combs, P. F. Twining, D. L. Pope, Aaron Spandorf and E. Bossard.

M-203 Trace Minerals in Poultry Nutrition. G. F. Combs, W. C. Supplee, R. D. Creek, N. V. Helbacka, B. Panda and O. D. Keene.

M-204 Nutrition and Bone Anomalies in Chicks and Turkeys. R. D. Creek, Valeria Vasaitis and W. O. Pollard.

M-300 Factors Affecting the Fertilizing Ability of Chicken Semen. F. H. Wilcox, C. S. Shaffner, G. C. Harris, H. R. Wilson, U. B. Blackwood, C. E. Clark, R. G. Clark and R. E. Seagrave.

M-301 Effect of Ambient Temperature on Efficiency of Broiler Production. C. S. Shaffner, G. F. Combs, G. D. Quigley and D. L. Pope.  
M-400 Effect of Protein Adequacy on the Efficiency of Selection for Early Fattening of Turkeys. C. S. Shaffner, G. F. Combs and G. D. Quigley.

**Department of Veterinary Science**

D-52 Respiratory Disease of Poultry. H. M. DeVolt, P. J. Vasington and A. P. Holst.  
D-57 Epizootiology of Equine Encephalitis in Maryland. R. J. Byrne and M. J. Collins.  
D-58 Infectious Bovine Mastitis. J. D. Kornder and Rita Sue Showalter.  
D-59 An Investigation of "Air-Sac Infection" in Poultry. M. M. DeVolt, J. K. Noel and R. W. March.  
D-60 Investigations on Brucellosis of Cattle. Cornelia M. Cotton, Claire B. Wolford and Gertrude M. Jones.  
D-61 A Study of Ruminant Metabolism with Emphasis Upon Its Relation to Ketosis. R. B. Johnson.  
D-62 Pathology of Breeding Failures in Cattle. R. J. Byrne, F. S. Yancy and W. R. Anderson.  
D-63 Study of Bovine Respiratory Diseases. R. J. Byrne, S. C. Chang, L. J. Poelma and F. M. Hetrick.







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